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PRACTICAL STAIRCASE JOINERY

PAUL N. HASLUCK

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PRACTICAL STAIRCASE JOINERY

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WITH NUMEROUS ENGRAVINGS AND DIAGRAMS

EDITED BY

PAUL N. HASLUCK

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PREFACE.

PRACTICAL STAIRCASE JOINERY contains, in a form convenient for everyday use, a comprehensive digest of information, contributed by experienced craftsmen, scattered over the columns of BUILDING WORLD, one of the weekly journals it is my fortune to edit, and supplies concise information on the general principles and practice of the art on which it treats.

In preparing for publication in book form the mass of relevant matter contained in the volumes of BUILDING WORLD, much of it necessarily had to be re-arranged and re-written. From these causes the writings of many contributors are so blended that it is difficult to distinguish any for acknowledgment.

Readers who may desire additional information respecting special details of the matters dealt with in this book, or instruction on any building trade subjects, should address a question to BUILDING WORLD, so that it may be answered in the columns of that journal.

P. N. HASLUCK.

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PRACTICAL STAIRCASE JOINERY

CHAPTER I.

INTRODUCTION : EXPLANATION OF TERMS.

STAIRCASING is a stumbling-block to many a young carpenter and joiner, who will find many things that he does not now understand made clear to him by the perusal and study of this volume. In this handbook the examples of staircase joinery described and illustrated are arranged progressively, beginning with the simplest and leading gradually to the more elaborate kinds of work. The book will thus be found to afford a convenient means of acquiring a very complete knowledge of the principles of the art.

The examples shown have been selected from a number that came under the personal observation of a practical staircase hand, who in nearly every instance took part in the planning and construction of the staircases described.

It is necessary to master quite thoroughly each example before proceeding to the next, familiarity with the more elementary details being essential to a sound knowledge of the more advanced practice. There can be no jumping suddenly to the advanced stages, which can only be reached by slow and regular steps.

Before proceeding with the examples it is advisable to explain clearly what is to be understood by the term "Staircasing," and by other more or less technical expressions relating to the subject. The technical terms used in the succeeding sections will also be briefly defined on their first occurrence. Meanwhile, the following short provisional glossary will help to afford a clear understanding of the instructions which it immediately precedes :—

Stairs: The complete set of steps included between two successive floors—between the ground floor and the first floor, or

between the second floor and the third floor, for example; these being the "ground floor stairs," the "second floor stairs," etc. *Staircasing:* That branch of house joinery comprised in constructing and putting in the staircases of a building. *Staircase.* The combination of woodwork put into a building to give access between its upper and its lower floors. *Stairway:* The space, in designing a building, set apart for receiving staircases. *Riser:* The upright portion of a step, against which a person's toe points when ascending the stairs. *Tread:* The flat part of a step—that on which a person's foot is placed when ascending or descending the stairs. *Nosing:* The front edge of a tread so far as it projects beyond the riser that supports the tread. *Step:* The formation composed of riser and tread; a succession of steps makes a flight. *Flight:* A succession of steps not interrupted by a landing or by winders. *Going*: This is usually equivalent to the length of the space covered by the whole of the treads. Thus, in a flight composed of ten treads, each 9 in. wide without the nosings, the going would measure 90 in. *Winder:* A step that has its tread wider at one end than at the other, thus causing the stair to wind or twist round, whereas an ordinary step ascends in a straight line. A stair composed wholly of winders is a spiral or "corkscrew-like" staircase. Winders allow of a staircase being built over a smaller area than it can be when straight steps are used. Use is also made of winders to convert what would otherwise be a half-landing (which is level from end to end) into a series of steps, and when these are built round a good-sized well they form that masterpiece of joiners' work — the geometrical staircase. Nevertheless, as a matter of choice, landings should be preferred to winders; a landing affords a rest in a long flight of stairs, and has also the advantage of safety; for it is obvious that winders—that is, treads gradually tapering to a point round the newel—do not afford so good a foothold as a landing. It is also necessary at times to introduce a landing at a place where a door opens directly on the staircase, and here winders, unless specially arranged, would be impracticable. *Width:* This is generally equal to the length of two steps and a little more, the extra width being occupied by strings, newels, handrails, and by a well or clear vertical space between the midmost end of each two successive flights. In the first example taken (see p. 18), there is but one flight, and so the "width" is equal to the length of one step and the strings on each side. *String:* The slanting

boards of a stair, to which the ends of treads and risers are fastened, or against which they abut. Strings may therefore be compared with the sides of a ladder into which the rungs (= steps) are fixed. *Close String Stairs with Newels:* This class of stair is so named on account of the outside string-board being close—that is, not cut, as in an open string staircase, where each step is cut out on the string itself, instead of being housed in. *Wall String:* The string that goes against a wall. *Outside String:* The string not against a wall. *Close String:* A string to which the treads and risers are affixed by making grooves in the string to take their ends. *Open String or Cut String:* A string to which the treads and risers are affixed by cutting notches completely out from the string. *Newel:* An upright post, placed parallel with the balusters at the topmost or the lowest step of a flight. A newel is frequently made of mahogany or some better wood than pine, and is invariably much thicker than the adjacent balusters. *Drop:* The ornamental turned end of a newel which extends downwards beyond the outside string and plaster. *Draw-boring:* A method of fastening together two parts, one of which has a tenon on it and the other a mortise in it. The draw-boring consists in boring with a bit a hole through the sides that inclose the mortise, and another hole through the tenon slightly nearer the shoulders, so that when the tenon is put into the mortise, and a peg of hard wood, fitting the holes, is driven through both, the tenon is drawn home tightly into the mortise. *Landing:* That part of a floor immediately around the top or bottom of a flight; or a flat boarded space coming as a break between two flights whose goings lead in different directions. A landing may be considered either as part of a floor, usually separated from the rest by partitioning, or as a tread extended horizontally till it reaches an inclosing wall or partition. A landing between two floors may be called a half-landing, as distinguished from a full landing. *Well:* The vertical clear space left in a well staircase between the middleward ends of successive flights and the centre of the stairway. In looking downwards over the balusters of a well staircase, the lowest floor can be seen from the top floor. A well staircase is of rare occurrence in small houses.

The foregoing definitions, which refer chiefly to structural details, may now be supplemented by brief descriptions of the most usual forms of staircase.

The plan of a stairway, although usually rectangular, may, according to requirements, be round, oval, polygonal, or of any other regular or irregular shape. In any case, it must be accurately measured and drawn. Irregular plans are only likely to appear when their use is compulsory—no architect would design one from choice. But in erecting a new house hemmed in by others on an old site in a cramped position, there is often no choice between a crooked plan and none at all. In most cases the outline of the plan can be drawn from two measurements known as the "going" (see p. 10) and the "width" (see p. 10).

In plain staircasing, such as that seen in the great majority of dwelling-houses, a rectangular space is left through each floor. In that way a clear, continuous stairway is provided from roof to basement, and the staircasing is all confined within three continuous vertical walls or partitions; and each flight, which is usually straight—that is, without winders—may be considered as representing an elaborated ladder, the upper end of the flight resting against the widest surface of a trimmer. The trimmer, or its equivalent, crosses the stairway with its upper surface at the level of a floor, or else about half-way between two floors. Its ends are tenoned into beams or joists, or else built into the brickwork of the walls. Its upper surface helps to support the flooring boards, and these at that spot form a landing.

The simplest form of staircase is a single flight reaching between floor and floor, with no winders. The staircase composed of two flights is preferable as being less steep than that consisting of one flight; the lower flight leads between the lower floor and a half-landing, and the upper flight leads between the half-landing and the higher floor.

Spiral staircases occupy less ground space than any other kind, and the more a staircase departs from the spiral form the more ground will its plan occupy; but walking up or down a spiral stair is generally found toilsome and fatiguing. The ascent of towers and monuments is usually effected by means of a series of winders, and very tiring they prove, because of the great upward progress they give as compared with the smallness of the horizontal or forward motion accompanying it, and partly because of the constant round-and-round movement required. But where the spiral is built over an extensive plan, it may be made to slope very gradually, and the treads, instead of being narrow throughout and brought to an undesirable point at one end, as must

necessarily be the case in a restricted plan, can be built round a well, which, if very large, gives a step almost as easy to ascend as that possible in a straight flight. Again, in winding once round the well of such a stair—or round the central newel if there is no well—it is necessary that the ascent made shall somewhat exceed the height of the person using the stair; and if the spiral path is round a very large well, it will have a correspondingly large number of steps, and thus be easier of ascent.

In order to turn this course of instruction to the best advantage, the reader should not merely study the figures illustrated, but himself make all the drawings to scale; and, having made the drawings, it is further desirable to construct models to the same size as the working drawings prepared. By the introduction of an extra step, or of some small modification of the original, the exercise will be rendered more valuable to the student, who will require to exercise more thought. A drawing to scale is one in which all parts of the original object represented are drawn smaller or larger, and in correct proportion. For instance, a doorway actually measuring 7 ft. high and 3 ft. wide might be drawn 7 in. high and 3 in. wide. In this case the *scale* would be called "one-twelfth," as all the lines in the drawing would be one-twelfth of the length given in the original. The use of sectioned drawing paper is of great assistance when working to scale, as by this means all the measurements can be at once determined without requiring the continual use of a divided measure such as a foot-rule. In drawings of one-eighth actual size, for instance, the sectioning would conveniently be made by lines an eighth of an inch apart; the space between every two lines would then show one inch to the working scale. This sectioned paper, which can be bought at most places where drawing materials are sold, is ruled from edge to edge, both vertically and horizontally, with a series of parallel faint blue lines. These lines form equal squares, their sizes being varied to suit different requirements.

For models, a scale of one-sixth is very suitable, and the sectioned paper for this will have six or twelve lines to the inch. Spacings of eight lines to the inch, giving a scale of one-eighth, are rather small. A model of a flight ascending 12 ft. will in the former case be only 24 in. high, which is not inconveniently large for putting together as a whole, and is yet big enough to allow of the correct measurement of details. In making the

models, it is quite as necessary to keep to correct thicknesses as to observe correct widths and lengths; and, indeed, unless the thicknesses are accurately proportioned the result, instead of being a creditable and neat example of woodwork, will be but a clumsy botch, and the whole object of constructing the model will be defeated.

Before a staircase can be constructed it is necessary to know exactly the size and the shape of the space allotted to it in the building for which it is intended. It is also necessary to know what doors, windows, or other openings or recesses, there are in the walls that inclose the stairway, so that these may be left unencumbered by the woodwork when the stairs are constructed and put in. These particulars are ascertained either from a drawing or by actual inspection and measurement.

A few more explanations of terms—relating on this occasion to drawing and planning—are introduced at this point in order that the succeeding practical instructions may be rendered fully intelligible even to the beginner:—*Set Out:* To draw upon paper, or upon materials such as planks; the latter are afterwards cut to the shape so marked and drawn. *Plan:* A drawing of anything, showing it as it would appear if looked at from a point directly overhead. The floor of a room is its plan. *Elevation:* A drawing of any object, showing it as it would appear if looked at from the front. The walls of a room are elevations of its sides. *Side Elevation:* A staircase side elevation shows the wider surfaces of the strings, and the ends of the steps. It is invariably drawn within a rectangle, whose width the going way of the stairs equals the going plus the breadth of the landing, and whose height is equal to the distance between the top surface of the boards forming a lower floor and the top surface of the boards of the next floor above. All side elevations are sectional; usually the section is taken through the middle of the plan. *End Elevation:* A staircase end elevation shows the edges of the strings and nosings, and the widest surfaces of the risers; it is seldom required or drawn. A plan and a side elevation are identical in length, and all parts measured along the one are the same as if measured along the other. Widths can only be got from a plan or from an end elevation, and heights can only be got from elevations. The going and lengths can only be got from the plan or the side elevation. *Section:* A drawing that shows the shape of a surface as it would appear

supposing that the object had been cut through as by a saw. When a loaf of bread is cut in two with a knife, the surfaces exposed on separating the parts are sections through the loaf. The plane of section is the direction taken by the cutting edge, and it may be made through any part, horizontally, vertically, or slanting at any angle as may be required. *Projection:* A method of drawing by which one view, either of the whole or a part of an object, is obtained by drawing projectors (construction lines) from one plane to another. In most cases the plan can be largely projected from the elevation, and the elevation can be projected from the plan, whilst sections are obtained from combinations of the two. *Development:* A curved surface as it would appear after being stripped from the solid whose exterior it formed, and then laid flat on a plane surface. The curved surface of a tin canister or of a pill-box, when thus developed, or unwound and laid on a flat surface, is found to be a rectangle. The curved surface of a cone develops as a more or less incomplete disc, the deficiency being a V-shaped piece with a curved base. Only such solids as have curved surfaces that will allow of a straightedge being laid on them so as to touch uninterruptedly from edge to edge at one or more parts can be developed. A cone and a cylinder or parts of a cone allow of this, but balls, eggshells, or other edgeless objects or parts of them, do not.

CHAPTER II.

SIMPLE FORM OF STAIRCASE : HOUSED STRING STAIR : MEASURING, PLANNING, AND SETTING OUT.

THE first staircase illustrated is of the most simple description, and in this respect will form an excellent object-lesson for the beginner. It is called a housed string stair, because the treads and risers are housed or grooved into the strings. In Fig. 1, A is the floor level, B is the skirting, C the landing, D the trimmer joist.

For taking dimensions on the building a rod is necessary, say

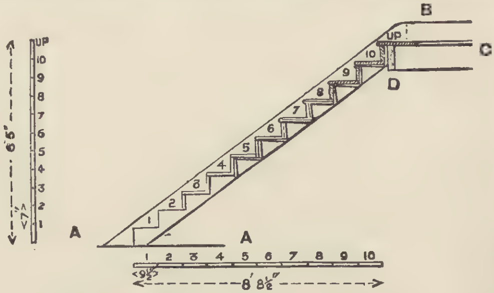


Fig. 1.—Measuring a Flight of Stairs.

an inch square, and of sufficient length to reach from floor to floor. One end should be perfectly square ; stand this on the bottom floor, and, holding it quite vertically, mark the height between floors on rod, this being called the "rise."

Having taken the distance from floor to floor, as shown on the left in Fig. 1, mark off the rod to this length ; then to find the number of steps divide this length into as many equal parts of as near 7 in. as possible. The height in Fig. 1 is shown as 6 ft. 5 in., which gives eleven steps, or, practically, ten and the landing.

Then consult the plan of the building, noting the riser starting and landing ; this is termed the "going." Now determine how far the stairs may be allowed to spread out, and divide this into ten equal parts, as shown at the bottom in Fig. 1, each part being

the width of a tread. This is taken at 8 ft. 8½ in. Of course, in Fig. 1 the height is taken at 6 ft. 5 in., and the length or going at 8 ft. 8½ in., for the purpose of illustrating the explanation. The rise and tread can be set out in good proportion as follows :—Easy

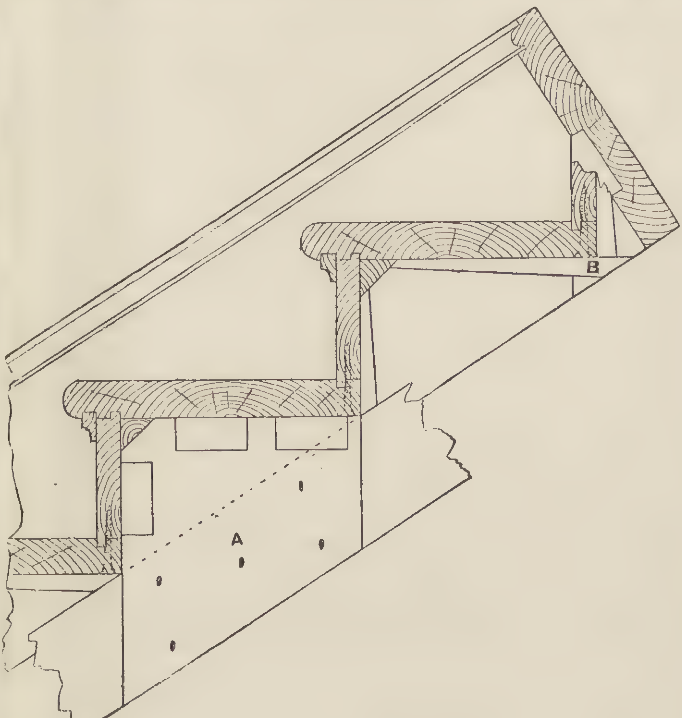


Fig. 2.—Section showing Treads, Risers, and String.

rises are between 6 in. and 7 in., and working to the rule that twice the rise added to the going should equal 23 in. gives the tread as ranging from 9 to 11 in. Fig. 2 shows a section through treads and risers, also the elevation and section of a portion of wall string. A shows a portion of the middle carriage piece with rough bracket nailed to it, which should be glued and blocked to the tread and riser as indicated. B shows one of the wedges;

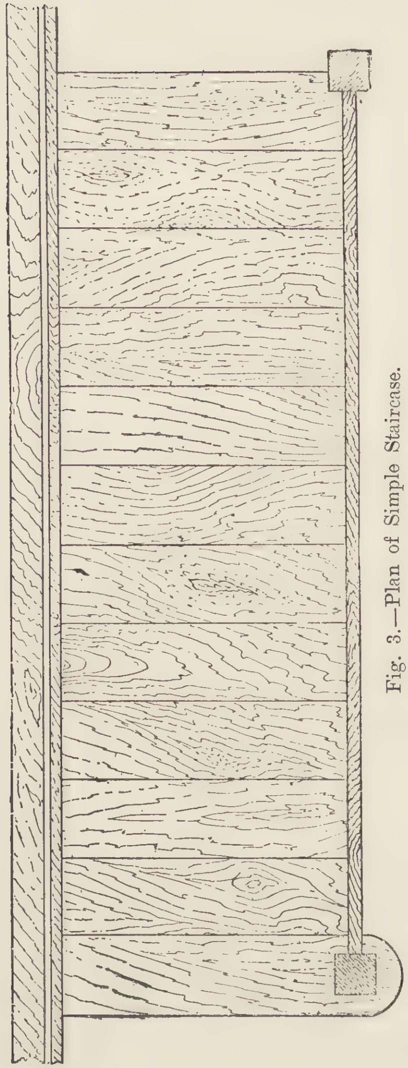


Fig. 3.—Plan of Simple Staircase.

these, when glued and driven in tight, fasten the treads and risers into the housing of the wall string.

Make a note of door openings ; and if these are near the foot of the stairs, carefully mark this also on the rod. It should also be noted whether stairs, if finished at the bench, can be got into their place in the building, as an error in this direction may give serious trouble. Then take the rod shown in Fig. 1 and space it into as many equal divisions as there are to be risers in the staircase. Treat the "going" in the same way, only space one division less. A plan of the stairs (Fig. 3) should then be drawn on a board to a convenient scale, say $1\frac{1}{2}$ in. to the foot.

Great care should be taken in making the pitch - board (Fig. 4) an essential in good staircase making ; for, unless the pitch-board is perfectly square and true, the tread will not be level when got into position with the risers

upright. To make the pitch-board, take a piece of dry stuff of any hard wood about ⅜ in. thick, and shoot one side and one end perfectly square and true, just as if making a plain set square, and on one edge set off the going, and on the other the rise. Connect these two and saw the wood to this line; this will give the pitch-board as shown in Fig. 4, in which A is the template, B the pitch-board, and E a section of the template.

The lengths of wall and newel strings can now be ascertained. These strings are, as already explained (see p. 10), the pieces

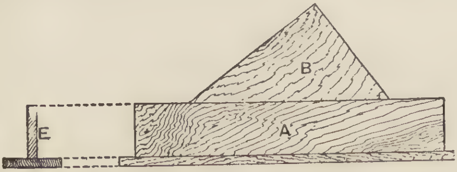


Fig. 4.—Template with Pitch-board.

which reach from floor to floor, and into which the treads and risers are housed; the one next the wall is called the wall string, and the other the outer string. One side and one edge of the wall string must be squared, but the outer string should be trued all round. The strings, usually 9 in. wide, might be 11 in. wide if strength is required, when the line on which the pitch-board

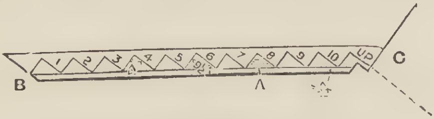


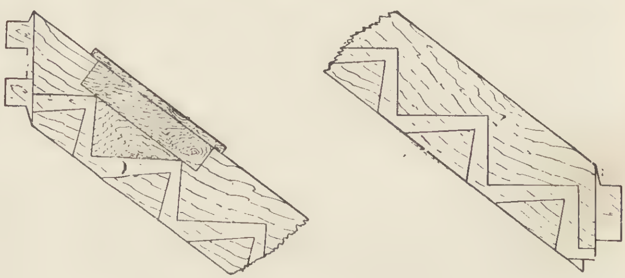
Fig. 5.—Applying the Pitch-board.

is set should be about 2 in. from the edge. Lay the wall string on the bench, using the template and pitch-board as seen in Fig. 4, with strips for marking thickness of tread and riser; the nosing can be marked also if desired. Then draw a line along the entire length $1\frac{1}{4}$ in. from one edge, place the longest side of the pitch-board on this line, and starting about 9 in. from the left-hand end, mark off as many triangles or steps as are required (Fig. 7).

In applying the pitch-board, commence at the bottom, keeping the rise towards the top. Number each riser in turn, as

shown in Fig. 5, so as to avoid the not uncommon mistake of putting a step short or a step too many in the flight. In Fig. 5 A is the pitchboard, B the bevel for floor, and C the joint for skirting. It will be noticed that ten steps and one extra (or what is called up) will be required, the riser of step 11 or up giving the line of joint between the top of the wall string and the skirting on the floor or the landing above, and the line of going or tread giving the bevel of the floor below. The same bevels give the notching of the string to fit over the trimming joist (Fig. 1). The string is now ready for marking and cutting the housings, as shown in Figs. 6 and 7.

The central part of Fig. 1 shows the string in position,



Figs. 6 and 7.—Sections showing String Set-out.

with steps 1 and 2 simply marked to the shape of the pitchboard shown at B in Fig. 4; but steps 3 and 4 have the thickness of the treads and risers marked. The treads and risers in this case may be made out of 1-in. stuff, which will be about $\frac{7}{8}$ in. thick when finished. The next two steps (5 and 6) have the wedging shown, Nos. 7 and 8 show the complete housing with nosings bored out, and Nos. 9 and 10 show the treads and risers in place and wedged, as shown in the enlarged drawing (Fig. 2); Fig. 6, which is a one-fourth full-size section, shows how the stairs are put together.

After marking the string as in Fig. 5, set off below the line of treads and behind the line of risers $\frac{7}{8}$ in., which is their thickness; then slide the pitch board along, and draw this thickness parallel to the existing face line of treads and of risers. Now allow for wedging, and thus ascertain the exact

width of the housings, which should be $\frac{1}{2}$ in. deep. A few centrebit holes may then be bored in the space marked for housing the tread and riser, and cleaned out with a chisel; then the remainder can be cut with the tenon saw, and cleaned out to the depth of $\frac{1}{2}$ in.

Cut out the housings for the treads within $\frac{1}{2}$ in. of the face line of the risers, as shown at B, Fig. 8; then bore with

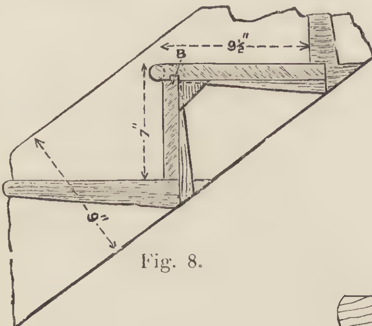


Fig. 8.

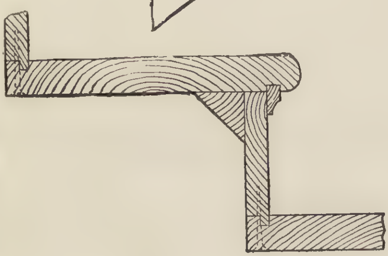


Fig. 9.

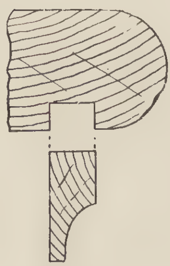


Fig. 10.

Fig. 8.—Section showing Riser housed into Tread. Fig. 9.—Section showing Tread and Riser. Fig. 10.—Nosing and Scotia of Tread.

a $\frac{7}{8}$ in. centrebit a hole of the same depth as the housing, and this will give a sharp curve for the nosings to fit up to, which would have been destroyed by the saw if the boring had been done before the rest was cut out. Now follow with the housing for the risers, taking care that the front of the saw does not knock against the top edge of the tread housing—an accident that would leave a very unworkmanlike effect when the stairs were finished.

The outer string should now be planed on both sides and

treated in the same manner, care being taken that it is marked so that it will pair with the wall string. Now prepare the treads and risers as shown in section by Fig. 9, cutting them to the exact length required by the width of the stairs, and allowing for thickness of strings after deducting depth of housings. The treads are wider by the projection of nosings

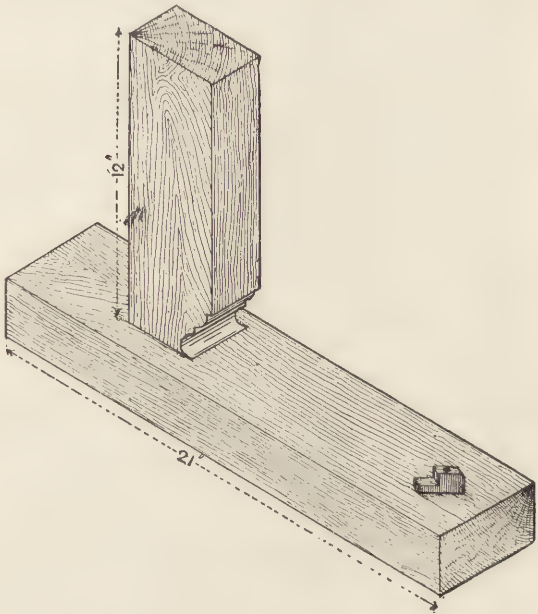


Fig. 11.—Cradle used in Staircase Joinery.

than the going, and the risers are less the thickness of tread plus the tongue which is fitted into the treads; all of which is shown in Fig. 9. The steps and risers may be put together, after they have been nosed and grooved for the scotia, as shown in Fig. 10; for this work, a cradle, Fig. 11, is used. The object of this appliance for fixing stair treads and risers together is that they shall be strongly held with the parts at right angles, and thus kept in position whilst the glue hardens. To enable this to be done it is necessary that enough shall be

cut away to allow the nosing and scotia room in the angle, and that the two or more cradles shall be fixed on the bench parallel and out of winding. It is advisable to use stuff about $4\frac{1}{2}$ in. by $2\frac{1}{2}$ in., mortising the horizontal piece, and making tenons on the vertical part, which might be $4\frac{1}{2}$ in. by 3 in. or so, and placed so as to gain as much shoulder abutment as possible. Before fixing, cut out for nosing and scotia. A button or a ledge and wedge may be added with advantage for convenience in fixing.

One tread and one riser should now be glued together and blocked, keeping the blocks $1\frac{1}{4}$ in. away from the ends, to allow

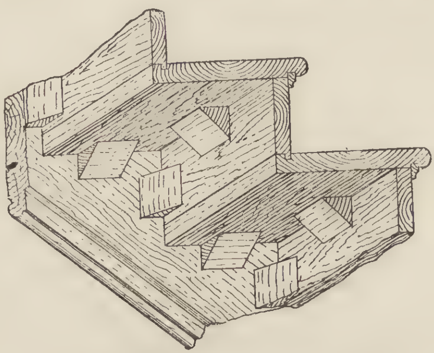


Fig. 12.—Steps fixed with Angle Blocks.

for going into housings, and for points of wedges in fixing to strings. When all the steps are glued up and dry, the nosings may be worked. It is better to have postponed the working of the nosings to this stage, because there is now less likelihood of the round edges getting damaged, and the mistake of rounding the nosings before ploughing for the risers is thus avoided. The wall string is now laid on the bench or floor, and the steps are placed in the housings; the outer string is laid on top, care being taken that the steps fit. The whole is strutted together from the ceiling, or in any other convenient manner, and it will be at once seen whether all is right; then all that remains to be done is to wedge the tread of one step and the riser of the next, working upwards and cutting off the projecting end of any wedge, and so on to the end. Screw

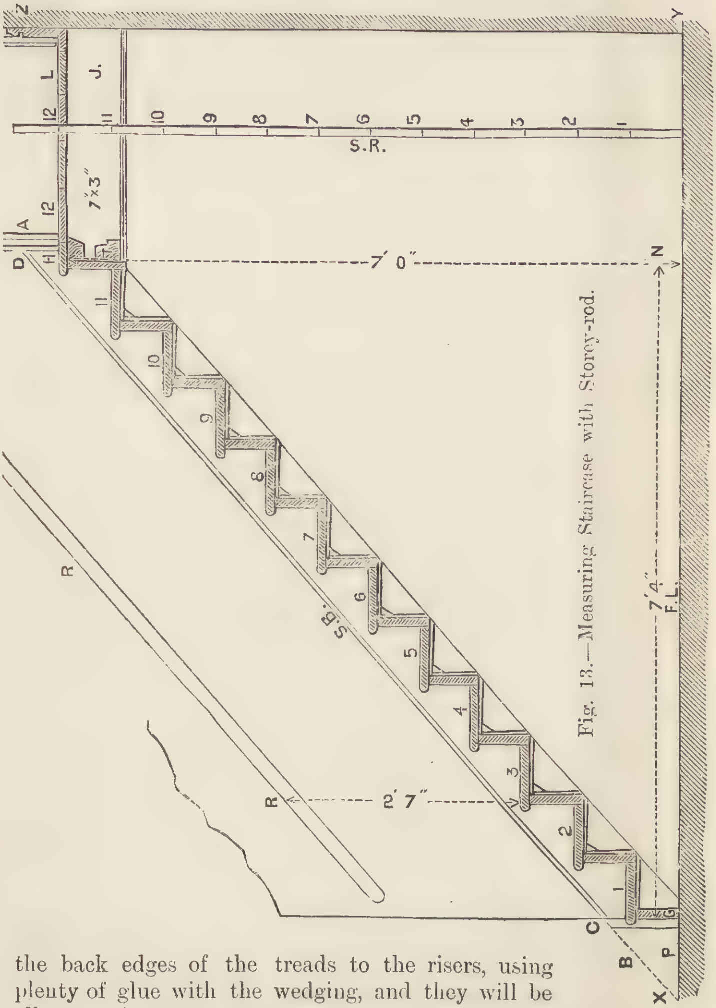


Fig. 13.—Measuring Staircase with Storey-rod.

the back edges of the treads to the risers, using plenty of glue with the wedging, and they will be all ready for fixing when the glue is dry. Fig. 12 shows the method of fixing the treads and risers to the string by glued angle blocks.

If measurements have to be taken from the stairway pro-

vided in the building itself, the method of procedure is as follows:—A wooden rod, called a storey-rod, say 12 ft. long and $1\frac{1}{2}$ in. square, is used for taking long dimensions, and to determine the number of steps and the breadth of treads and risers. The landings and floors being already laid, stand the lower end of the rod on the upper surface of the lower floor, and, having got the rod quite upright, mark on it the height of the lower surface of the upper floor or landing to which the first flight of steps is to lead. In Fig. 13 this distance is H N, and on applying a two-foot rule to the marks on the rod the actual height is found to be 7 ft. Put this down in a note-book kept for such purposes.

Next apply the rod along the going (for definition of this term see p. 10), which will be the distance from where the back surface of the lowest riser is to come, to a point N on the same level, immediately below where the back surface of the topmost riser is to come. This point is found by letting fall a plumb-line from the face of the trimmer T against which the topmost riser is fixed. The going thus found on the rod is measured with a two-foot rule, as before, and in Fig. 13 it is shown as 7 ft. 4 in. At the landing H L, a door 2 ft. 4 in. wide, and the architrave A (which is the wooden moulding that projects around an opening, such as a doorway, at the sides, rising vertically from the floor), are shown, and their positions and dimensions must be noted on a rough sketch made of the plan, and of any of the walls, should openings or other peculiarities in them make it necessary. The height and width of the trimmer joist J must also be noted on the sketch.

Now proceed to make a working drawing. Draw first the two lines at right angles, X Y representing the floor line and Y Z representing the wall face. Then from Y, towards X, measure off the length of the trimmer-joist to the point N, 3 ft., and from there the going N G, 7 ft. 4 in. along the floor line. Draw next lines representing the upper and lower surfaces of the joist and the thickness of the boards laid above it. The doorway, if present, must also be indicated, and of course all the measurements must be made to scale.

The next matter to determine is, how many steps there ought to be in the flight. Of course, the smaller each step is, the greater will be the number wanted, and *vice versa.* Although the landing H L is really the top step of the flight, it is always

necessary to consider that the treads are fewer by one than the risers, for the going terminates before the landing begins. In Fig. 13 the treads will accordingly be 11 and the risers 12 in number. It will be seen, on looking at Fig. 13, that the going G N, which measures 7 ft. 4 in., is wholly and exactly traversed or measured by the 11 treads—that is, of course, without reckoning the nosing that overlaps the front of each riser. Therefore, whatever the number of treads used, they must together, without the overhang, measure 7 ft. 4 in. in the example illustrated in Fig. 13, or whatever may be the length of the going in any other example. The same observations are true when applied to the 12 risers and the height H N.

Treads with a breadth of 10 in., and risers with a height of 6 in., may be taken as constituting the standard stair, easy and comfortable to use; but in most small houses, and for the back stairs of many large ones, space is too much restricted to allow of this standard being closely adhered to. In the case now under consideration, Fig. 13, there would not be quite enough going for nine such treads, and the height would only be 5 ft., with 10 risers, each measuring 6 in. Therefore it is necessary to alter the proportions and sizes to fit the stairway in hand.

For a flight of steps made with risers 6 in. high and treads 10 in. broad, the going and height must always bear definite proportions, and in the design of a well-proportioned house this detail would be attended to by the architect. Taking examples where there are from 10 to 19 steps, the following table shows the goings and the heights that would be necessary :—

Treads.	*No. of Risers.*	*Going.*	*Height.*
10	11	8 ft. 4 in.	5 ft. 6 in.
11	12	9 „ 2 „	6 „ 0 „
12	13	10 „ 0 „	6 „ 6 „
13	14	10 „ 10 „	7 „ 0 „
14	15	11 „ 8 „	7 „ 6 „
15	16	12 „ 6 „	8 „ 0 „
16	17	13 „ 4 „	8 „ 6 „
17	18	14 „ 2 „	9 „ 0 „
18	19	15 „ 0 „	9 „ 6 „
19	20	15 „ 10 „	10 „ 0 „

In the table just given, allowance is made for the risers being in all cases one more than the treads, and of course it is not necessary to consider the overhang or nosing in the calculation.

To return to Fig. 13. Here the space available is already determined, and so steps have to be calculated to fit it. The chief point about which there is any question is the number that shall be allowed, for whether the steps are 5 or 50, the proportion between riser and tread will be practically unalterable after the height and length of the stairway have been fixed. Remembering, then, the standard stair with a riser of 6 in., try how it will fit the example illustrated by Fig. 13. In the height given, there would be fourteen risers of 6 in. height. There would consequently have to be $14 - 1 = 13$ treads. Dividing the going, 7 ft. 4 in., by 13 gives 88 in. $\div\ 13 = 6\frac{10}{13}$ as the breadth of each of the thirteen treads. Thus the tread would be very little broader than the riser is high, and the standard proportions would have been widely departed from. To get nearer to the standard proportions there must be an increase in the height of the risers.

Arbitrary sizes are assumed for the example given. By dividing the height into twelve parts, 7 in. will be got for the height of the risers; and as eleven treads will then be wanted in the going, a division of this into eleven parts gives 8 in. as the breadth of each tread. The thickness of the boards used—$\frac{7}{8}$ in.—will, if the back edge of each tread is placed against the front surface of each riser, allow a nosing or overhang of $\frac{7}{8}$ in.

Here another factor in the matter may be considered—namely, the ordinary widths of boards that are available for sawing up into treads and risers. If the breadth and height of these can be arranged so as to figure out to exactly the width of sawn planks, much stuff and labour will be saved. The stock widths are 7, 8, 9, 10, and 11 in.

When referring to the various parts of a plank or other piece of wood, the following terms are uniformly employed in this book: "Length" means the dimension that coincides with the fibre-way of the wood or the direction in which it would split; "width" means the broadest dimensions at right angles to length; "thickness" means the shortest dimension at right angles to length; "edge" applies to the surface showing "thickness"; "end" applies to the "edge" that shows the ends and cross-section of the fibres.

The placing of treads below risers, or risers behind treads, is a matter that requires attention. It sometimes happens that by

reversing the positions named—that is, by putting the bottom edge of each riser on the top surface of each tread—a plank can be used without sawing off some portion of it, and much labour saved in the process. In calculating the width of the plank wanted for the treads, however, the nosing allowance must never be omitted. It does not enter into the question of the number of steps, and is usually determined either by the relative position of tread and riser or by taking a plank that is an inch wider, so as to provide for the nosing.

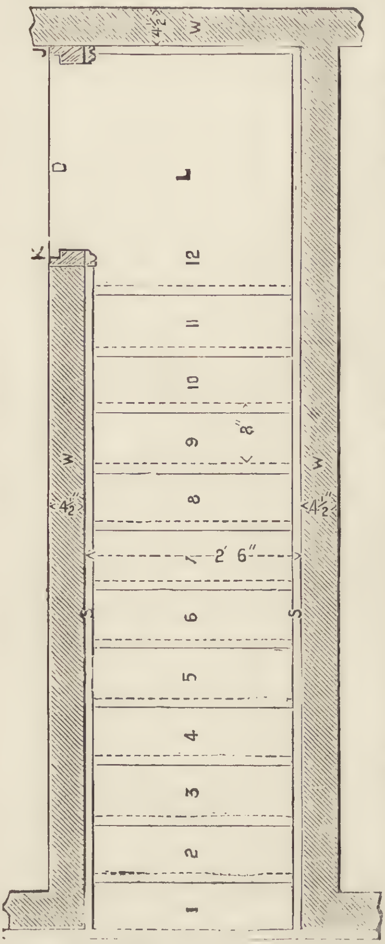


Fig. 14.—Plan of Staircase shown in section by Fig. 13.

The ends of the eleven treads and twelve risers can now be drawn, as in Fig. 13. Divide the going G N into ten equal parts along the floor line, each succeeding mark being 8 in. from the last, and 8 in. being left between the end of the line N and the mark nearest to it. From these ten marks, and $\frac{7}{8}$ in. from the left-hand end G, draw lines upwards, all parallel with Y Z. Those lines to the left need be only short ones; those to the right must be gradually increased in length till the last, at N H, is 7 ft. long (to scale). Along the line Y Z in the elevation make eleven marks, commencing the first 7 in. (by scale) from

Y, and making each succeeding mark 7 in. from the last. From these eleven marks draw lines across parallel with X Y to cross the twelve lines previously drawn upwards along X Y. Where these two series of lines cross make a dot with the pencil point.

From the elevation (Fig. 13), as far as it has now been drawn, project the plan (Fig. 14). Show on it the width, 2 ft. 6 in., between the outside surfaces of the strings S S, which distance

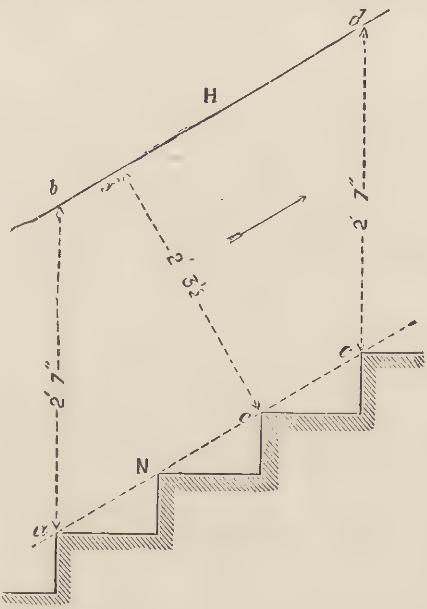


Fig. 15.—Determining Position of Hand-rails.

corresponds below it with the width of the stairway. Then draw the two lines inside to show the thickness of the strings—1 in. Then indicate the thickness of the walls, W, W, W, which, in Fig. 14, is 4½ in. for all three. Show the doorway D by a single line, and the jambs J K at each end of it. Letter the landing L, and then draw the edges of the twelve nosings in full lines, the twelfth being the nosing of the landing L. Number the treads with figures 1 to 12, as in Fig 14. Finally draw the dotted

lines $\frac{7}{8}$ in. behind the full nosing lines to show the front surfaces of the risers. With a hard pencil intensify the lines as far as is required to show the under surfaces of the treads and the back or right-hand surfaces of the risers. Then rub out the twenty-three superfluous construction lines drawn from XY and YZ.

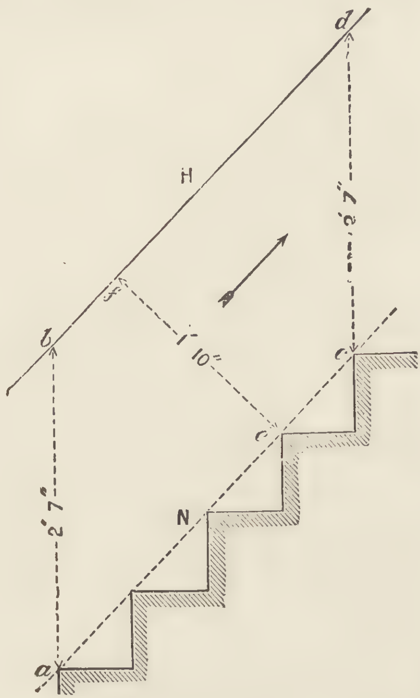


Fig. 16.—Determining Position of Hand-rails.

By using sectioned paper (see p. 13) this rubbing out can be almost wholly avoided, as the blue lines dividing the sheet into squares are themselves construction lines, and the length of the pencilled markings need not be drawn to exceed their finished dimensions. Draw the lines above the treads and to the left of the risers, representing the thickness of the boards, $\frac{7}{8}$ in., and extend the tread to form the nosing and round it off. Draw the

line G T (Fig. 13), to show the lower edge of the string, and the double lines, B D and the one close to it, to show the upper beaded edge of the string, which is shown on a larger scale in Fig. 2. The farthest of these double lines is 9 in. from the line G T, measured along a line at right angles to them. Measure 2 ft. 7 in vertically above the upper surfaces of any two treads, one near each end of the flight, and through the two points so obtained draw the upper of the double lines R R, indicating the handrail. This height is taken always on a line plumb with the riser, measuring from the top of the tread to the upper side of the handrail. In Figs. 15 and 16, N shows the line of steps and H the top of rail, the height (2 ft. 7 in.) being marked from *a* and *c* to *b* and *d* respectively, thus giving the height and pitch of rail. The line *e f*, Fig. 15, drawn perpendicular to the pitch, would be 2 ft. $3\frac{1}{2}$ in., and the corresponding line at Fig. 16 would be 1 ft. 10 in. only, although the height as taken plumb with the riser is the same. This difference in height measured on the line *a c* is of no moment, the body not being inclined in this direction, but upright from the steps. A person in passing up or down stairs naturally throws the body slightly backward or forward as the case may be. Therefore the most convenient place for the hand to rest on will be in a line with the body, and slightly in advance, and the height found by experience to best answer the purpose is 2 ft. 7 in., measured upon a line (as *a b*) plumb with the riser, from the top of the step or tread to top of the rail.

In such a staircase as that which is now being considered, the ends of the treads and risers are housed into the strings to a depth of $\frac{3}{8}$ in. on each side. Housing (see pp. 20 and 21) simply means sunk into a groove; the position of the latter is marked and is then roughly scooped out with centrebit, saw, and chisel, and afterwards finished with a special kind of plane called a router (Fig. 17). This housing will necessitate the making of the treads and risers $\frac{3}{4}$ in. longer than the actual space measures across the inside of the two strings. Reference to Fig. 14, p. 28, shows the space outside the two strings to be 2 ft. 6 in.; the strings are each 1 in. thick, so the space inside will measure 2 ft. 4 in. Then allowing $\frac{3}{8}$ in. extra for each of the housed ends, the length of treads and risers must be 2 ft. $4\frac{3}{4}$ in. ($\frac{3}{8} + \frac{3}{8} = \frac{3}{4}$ in.). In sawing planks into treads and risers, saw out the number of each required to this length from $\frac{7}{8}$-in. wood, making the treads 8 in. wide and the risers 7 in. wide as has already been shown.

From some 1-in. plank 9 in. wide, cut off the strings so marked in Fig. 13, p. 24, and marked S S in Fig. 14. Measure the distance B D (Fig. 13) to scale, and having checked the length by actual application of the storey-rod, cut off the exact length required.

Make a pitch-board (Fig. 18) from ½-in. pine or mahogany. Mark upon it two lines at right angles—A B, 7 in. long, and A C, 8 in. long. Then draw a line joining B and C. Write clearly on each side of the board "riser" and "tread" where indicated in Fig. 18. Draw a line D E parallel with and 2 in.

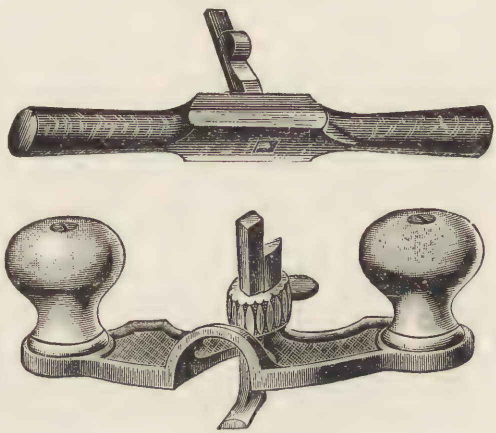


Fig. 17.—Router Planes.

from B C. Saw through the board on the lines A, D, E, so as to get a three-cornered piece, as shown in Fig. 18. To the edge D E screw or nail a guide-piece S, having its edges, as shown in the section, projecting above and below to the extent of an inch or so. In the section mentioned, T is the triangular piece and S is the slip screwed to it. The projection of S on each side allows of the pitch-board being used for either the right-hand or the left-hand string. A pitch-board is used in marking the position of the housing grooves on the side of a string-board, and is applied as shown at Fig. 19, where P B is the pitch-board. Apply it, accordingly, at the end of the board from which the string is to be made, in the manner

shown in Fig. 19, with the "tread" edge, Fig. 18 (A B in Fig. 19), outwards—that is, towards the left (towards the bottom in Fig. 19). Push A, Fig. 19, as near to the end as it will go, and with a striking-knife draw a line on the string-board to follow the edge A B, guided by the pitch-board, which is meanwhile held tightly pressed against A C. The striking-knife is a marking tool, used like a pencil, often made from an old dinner-knife, the blade

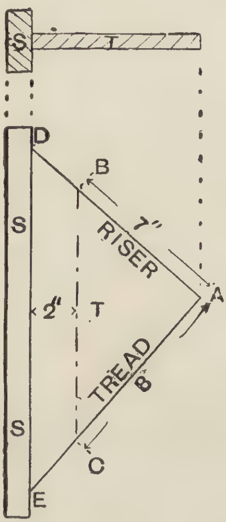


Fig. 18.

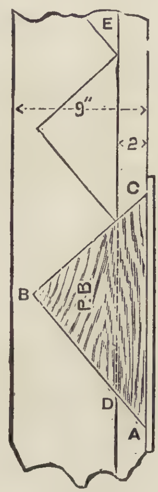


Fig. 19.

Fig. 18.—Plan and Section of Pitch-board. Fig. 19.—Applying Pitch-board to String.

of which is made sharp and lance-shaped at the end: it makes a fine line on wood, and is used in preference to a pencil for marking. Remove the pitch-board, and with a straight-edge continue A B across to the upper edge, and saw off the board along the line so marked. This end of the board will now fit the floor when in position in the stairway. It has, however, yet to be cut to the correct bevel at its other end. D E, Fig. 19, is the nosing line. Along the string-board, from end to end, 2 in. from the edge C D (Fig. 20), draw a line A B parallel

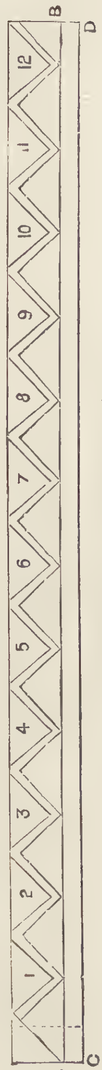


Fig. 20.—String-board marked for Housing-groove.

with the edge. This figure shows the string, which pairs with that shown at Fig. 13, and the figures upon it commence at the upper end. Now apply the pitch-board at the other end of the string, and with the striking-knife, along the edge marked "riser" (B C, Fig. 19), mark a line as close to that end as it can be drawn; then cut off the piece not required. The string should now stand fair on the floor, and lie fair against the joist in the space where it is to be fixed, as shown in Fig. 13, p. 24.

The housing in the string for receiving the ends of the steps has next to be marked and routed out. At 7 in. from the bevelled edge of the lower end of each string draw a line parallel with the bevelled edge, using the pitch-board as guide for the marking-knife. Seven inches from this draw a second line, parallel with the last, using the pitch-board again. Continue this marking till the upper end of the string-board is reached. Now go over the same ground and draw, with the other edge of the pitch-board as a guide, a similar series of lines, from the same starting-points, along A B, Fig. 20. A zigzag line, represented by the bottom one of the nearly parallel pair in Fig. 20, will now have been made on the string-board. By using the pitch-board, a series of small errors is apt to be made, so it is safer to use a rule as well. C D is the beaded edge.

A wedge-strip marking-gauge is next wanted. This is a piece of thin wood; $\frac{1}{4}$ in. will do, about 1 ft. long. Plane one edge smooth and true, and cut off one end at right angles. Make a mark at this end $1\frac{1}{8}$ in. from the planed edge; then 8 in. from the first mark make a second, $1\frac{1}{4}$ in. from the planed edge. Join these two marks, and plane the wood down to the line, thus forming a wedge $1\frac{1}{8}$ in. wide at its small end and about 12 in. long. For housing steps composed of wood more or less than $\frac{7}{8}$ in. thick, wedge-strips of larger or smaller size than this may be wanted;

but the treads and risers in the present example are $\frac{7}{8}$ in. thick, and the wedge-strip is made to suit. Apply the wedge-strip as shown in Fig. 21, placing one edge to agree with the lines already drawn, and draw another line (which will not be quite parallel with it) along the other edge of the wedge-strip D E. Drawing a series of such lines will make a double line of zigzags, as in Fig. 20.

To mark the thickness of the housing, turn the string-board up on edge, and along the edge that is at the right of Fig. 21 mark, with a marking-gauge, a line $\frac{3}{8}$ in. from the side on

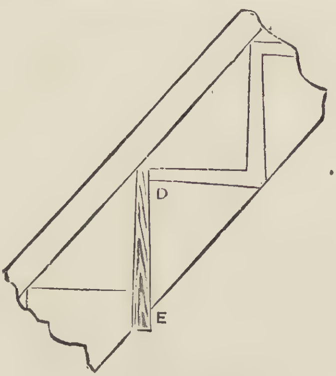


Fig. 21.—Applying Wedge.

which the zigzag is drawn. A marking-gauge is a joiner's tool consisting of a block of wood about 3 in. square and 1 in. thick, through the centre of which there is a square hole. Through the hole, fitting it snugly, there slides a rod of wood about 9 in. long. From one side of the square rod there projects, near the end, to the extent of about $\frac{1}{8}$ in., a piece of steel, like the point of a pocket-knife, and sharpened so that it will easily cut through deal. A wooden wedge, or a screw, turnable by thumb and fingers, fixes the rod in the hole at any point required. The steel is made to mark or cut a piece of wood in a line parallel to any edge along which the square block can be slid to ensure parallelism. The $\frac{3}{8}$-in. line defines the depth of the housing—that is, the depth to which the wood between the zigzag lines must be cleared out.

With a brace and bit bore a series of holes $\frac{3}{8}$ in. deep (F, Fig. 22), fairly closely together. Then, with a chisel, proceed to roughly finish the angle, as at G. Then, the angle having been got clear, a tenon-saw is to be used to saw through along G K and J H, and then a chisel roughly finishes the work. Finally, a router, shown at Fig. 17, p. 32, is used to finish the groove. The cutting-iron is set to project just $\frac{3}{8}$ in., and the housing-groove is thus the same depth throughout.

A nosing-plane, Fig. 23, is used to round the edge or the nosing of the treads, and a brace and bit are used to shape the

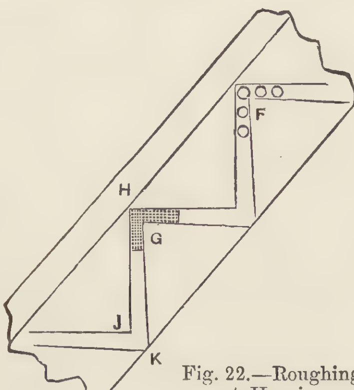


Fig. 22.—Roughing out Housing.

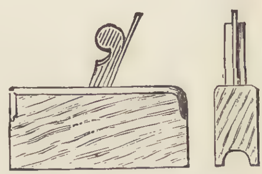


Fig. 23.—Nosing-plane.

ends of the grooves in the string to fit the rounded nosing. This series of bit-holes at the nosing ends should be made before removing any wood from the grooves. To find the centres into which to insert the point of the bit, draw lines between the tread lines, $\frac{1}{2}$ in. from and parallel to the first set, to cross the riser lines and the centres for the bit point will be at the crossing points. At the right-hand of Fig. 23 is an end view of the nosing plane.

Fig. 24 shows, enlarged, a part of the string, with steps in section, housed and wedged. The cross-hatched piece F F shows a section of the string there. The other letters refer to the following parts :—Thread, A ; riser, B ; wedge, C ; block, D ; beaded edge of string, E ; string, S. A better illustration of these parts, but without lettering, may be seen at Fig. 2. Fig. 25 is an enlarged view of the top end of the string where it joins the landing

(see also Fig. 6, p. 20). The letters refer to the following parts :— landing, L ; architrave, *d* ; nosing-board of the top tread or land-

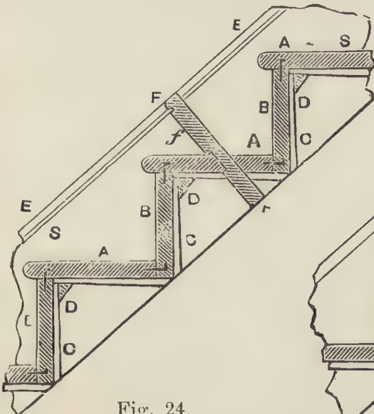


Fig. 24.

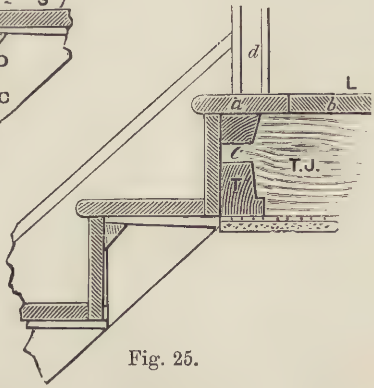


Fig. 25.

Fig. 24.—Section showing Housed and Wedged Steps. Fig. 25.—Section of Upper Part of Flight.

ing (which is not fixed in its place till after the stairs are in position), *a* ; floor-board, *b* ; trimmer-joist, T J ; tusk tenon, C ;

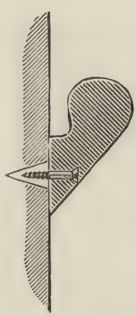


Fig. 26.

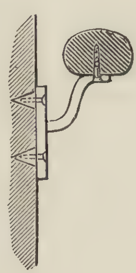


Fig 27.

Figs. 26 and 27.—Sections of Simple Handrails.

trimmer, T. The tusk-tenon is one-sixth as deep as the joist, and has its lower surface at the middle of the depth of the joist ; the projection below it, as shown, gives a firmer bearing.

At Figs. 26 and 27 are shown, in end section, two simple forms of handrails suitable for the stairs just described. They are fixed to the wall by first driving wooden plugs into holes formed by removing mortar from between two bricks, and then securing them either by screws inserted direct as at Fig. 26, or by iron brackets as at Fig. 27. At Fig 28 is shown on a larger scale a somewhat more elaborately moulded handrail.

To put the stairs together, lay one string on a flat surface with the zigzag groove upwards. Fit into the groove one set of ends of the treads and risers ; then put the other string on top and fit the top ends into their respective grooves. When possible, the fitting

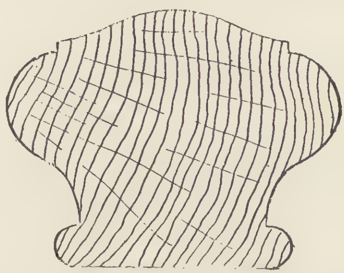


Fig. 28.—Section of Handrail.

should be done on a bench with a roof above that will allow of baulks or other pieces of timber being inserted between it and the bench top to form a kind of vice that will grip the strings together. Make perfectly sure that the front edges of the treads do not wind—that is, that they are all in parallel planes that form right angles with the 9-in. surfaces of the strings. Then, and not till then, glue and drive in the wedges, which must have been previously cut to the same taper as the wedge slips. Put nails through the risers, from behind and through the treads from the front as shown in Fig. 24. Then remove the confining timbers that act as a vice, and put nails through the strings into the ends of the treads and risers. Blocks D (Fig. 24) have now to be glued where shown, and the putting together is complete. These blocks are pieces of deal, triangular in section, and 2 in. long, made by cutting stuff 2 in. square into short pieces and halving across the angles. The two sides that are at right angles are glued and pressed into the angle formed beneath by

the junction of the fronts of the treads and the tops of the risers.

Before putting the stair finally together, it is as well to see that, in that condition, it can be got into the stairway of the house. If not, the wedging up must be done on the spot. The upper and lower bevelled ends of the strings, having been planted in position against the trimmer and floor, can be secured by nails driven aslant. The top tread or nosing-board of the landing is then put on. Blocks of wood put into the walls where the strings are to come will afford a hold into which nails can be driven, from under the stair, through the strings and into the blocks. The construction of the stair is now complete.

It sometimes happens that stairs are observed to creak soon after coming into use. The cause of stairs creaking is that the wood was not thoroughly dry when the stairs were made, so they have shrunk and require re-wedging up. This is a difficult job, especially if the underside of the stairs is boarded or plastered ; but if the worst trouble is on the landing, proceed as follows : Cut up the boards on the landing (this will expose the bearers, joists, or carriage pieces, as the case may be) ; thoroughly pin up, wedge, and nail all the bearers thus exposed ; nail he exposed portion of wall strings to the walls with large spikes ; screw fillets to the strings or joists, to take the ends of the landing-boards where they originally went into grooves or where cut, and re-nail the boards down. Taking up the landing may expose the whole of the trouble

CHAPTER III.

TWO-FLIGHT STAIRCASE.

THE staircase about to be dealt with is slightly more complex than those described in the preceding chapter, as, under the conditions, two flights are necessary. On reference to Fig. 29 it will be seen that there are two landings, one being placed at a height of 6 ft. from the ground floor—this height being varied to suit circumstances—the other at the level of the first floor. Of course, it will be understood that these sizes are taken only for convenience, to save space. In practice, even 8 ft. 2 in. would be much too low, as it would only give about 7 ft. to the ceiling line, which the bye-laws regulating the erection of new buildings would not allow, 8 ft. being the lowest limit. The measurements given however, will serve the purpose of illustration.

In making the working drawings, proceed as explained in the last chapter, by taking the height, width, and going upon the storey-rod, as shown in elevation, Fig. 29, where S R is the storey-rod, F L the height of first landing, and T L the height of top landing. Note that the going should properly be taken from the wall at the back of the top landing up to the doorway to the left, as it is always better to keep the stairs clear of the entrance to the rooms. The depth of the trimmer-joist should also be taken into account for reasons that will be seen as the work proceeds. In preparing the working drawings, first lay down the plan as in Fig. 30, showing the three inclosing walls W, the doorways, and the landings L. Next draw the elevation (Fig. 29), marking all landings and joists as shown, allowing $\frac{7}{8}$ in. for floor-boards at the top of the trimmer-joist L T J, and the same for laths and plaster at the bottom. Now divide the height to the first landing into as many parts as convenient; these have been taken as twelve. Do the same from the first to the top landing: this, it will be seen gives space for four risers. Now see how this will work for the going. The first landing projects 2 ft. 9 in. from the wall to the face of the trimmer T. From T, then, to the door D, Fig. 29, will be the distance available for the treads, or going.

Divide the width of the staircase, shown as 6 ft. in Fig. 30, into two equal parts, and on the centre line draw the newels

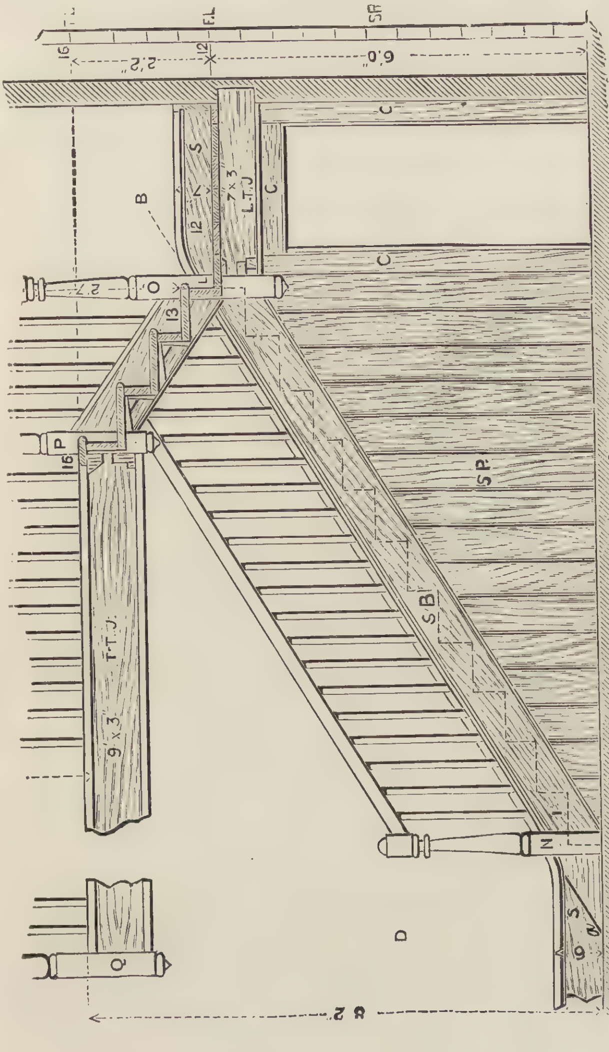


Fig. 29.—Sectional Elevation of Two flight Staircase.

N, O, P. It is very important to bear in mind the fact that in all staircases there is always one riser beyond the number of treads, on account of the landing counting as one tread. This being the

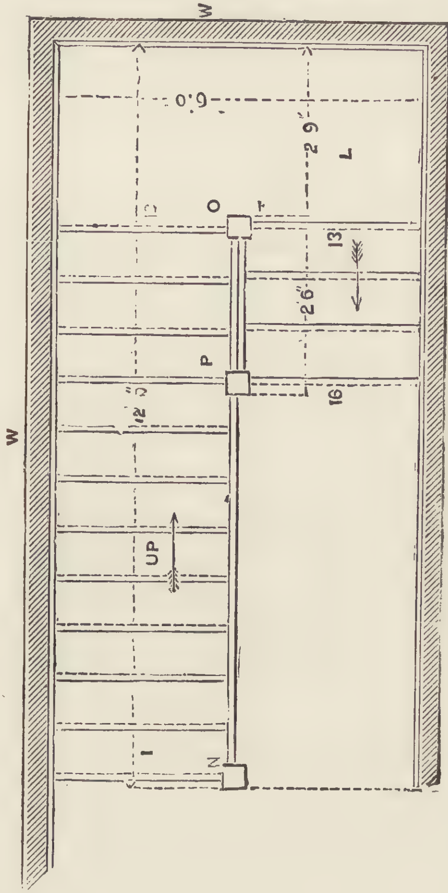


Fig. 30.—Plan of Two-flight Staircase.

case, as there are twelve risers in the flight, there will be only eleven treads to deal with; therefore, divide the space, from centre to centre, between the lowest, N, and the next higher, O,

into eleven equal spaces, as shown. There being four risers in the top flight, divide the space on the plan representing the going into three equal parts. By projecting lines from the plan to meet corresponding lines in the elevation, as described in Chapter II., the end view of the steps is obtained. In the elevation, at a distance 2 in. above the nosings, draw a line parallel with them, and at a distance of 9 in. below this line draw another line. These two lines together represent the width of the string. Now draw the newels, which are 4 in. square. At a distance of 2 ft. 7 in. from the nosings draw a line representing the top of the handrail, and another for the bottom edge of the handrail (see p. 31). Draw the top of the handrail on the landing at a height of 3 ft. 1 in. above the top of the joist. It is necessary to leave the newels square in

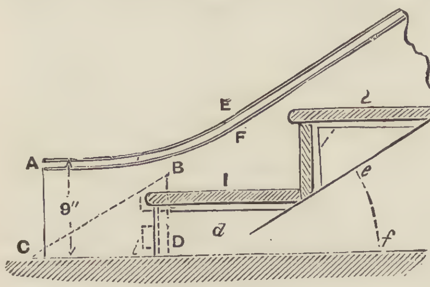


Fig. 31.—Wall String.

section from their lower ends to about 4 in. above where the top of the strings will come, and at their upper ends for about 1 in. above and below where the handrail joins them. The rest of the newel, between the two square-sectioned ends, is usually turned in a lathe to some ornamental pattern. Indicate the skirting-boards S, Fig. 29, spandril S P, the top trimmer-joint T T J, the balusters, the cupboard front C C C, etc., and the working drawing is finished.

Having completed the drawing, first measure the length necessary for the wall-strings—that is, from the ground to the first landing—by laying the rule along the top edge of string-board S B (Fig. 29) from A to B. This extra length beyond the newels is to allow for the easements to skirtings at top and bottom. (An easement is a graceful curve by which an angle is rounded off, or by which a straight line and a curved line are

joined with an easy sweep. Easements are usually drawn in freehand; see, however, p. 66. Take the length from the half-space landing to the top landing, Fig. 29. The length of the outside string can be taken from the outside of the newel O to the one at top P, allowing a few inches to cut away in making the final adjustments. The sizes for the newels can also be taken from the drawing. Having set out the pitch-board as before, but of course to a different pitch and length of tread and riser, apply it to the bottom end of the wall string, so that the edge marked "tread" on the pitch-board may coincide with C D (Fig. 31). Then by cutting the string off at this line, the pitch of the stairs is at once obtained, B C D being the angle between the line of nosings and the floor line. Now set out the spaces for treads and risers as

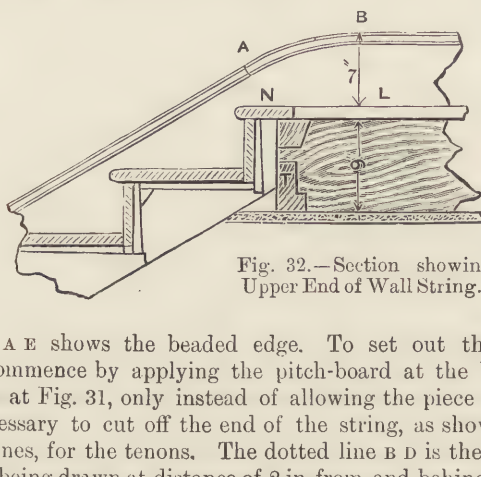


Fig. 32.—Section showing Upper End of Wall String.

before. A E shows the beaded edge. To set out the outside string, commence by applying the pitch-board at the bottom of string as at Fig. 31, only instead of allowing the piece to run on, it is necessary to cut off the end of the string, as shown by the dotted lines, for the tenons. The dotted line B D is the shoulder, this line being drawn at distance of 2 in. from, and behind, the first riser. The reason for this will be obvious when it is remembered that the going was taken from centre to centre of the newels, thus arranging for the risers at the lowest and at the highest steps being housed into the centre of the newel. The top of the string will be set out as seen at Fig. 33, only that the shoulder B D will be 2 in. in front of the last riser A B. The letters in this illustration (Fig. 33) not already mentioned are as follows:—C D, shoulder line for tenon and mortising; R, handrail; S, section of rail; F, floor; and T J, trimmer-joist. The tenons should be cut

with the shoulder on the inside of the strings, as at Fig. 34, and may be about 5/8 in. in thickness.

At the bottom end of the wall-string a piece (A C, Fig. 31) must be glued, wide enough to make out 9 in., the depth of skirting on the ground floor. At the top no such piece is necessary, the string being worked off to meet the 7-in. skirting, as shown in

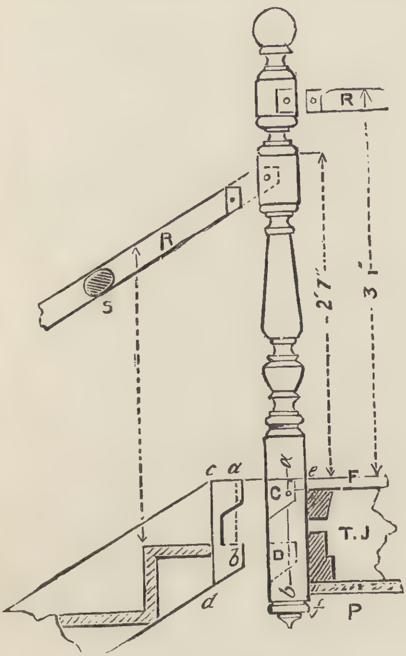


Fig. 33.—Outer String.

Fig. 34.—End of String with Tenon.

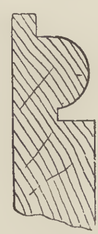


Fig. 35.—Beading on top of String.

Fig. 32, which is lettered thus:—A B, easement; N, nosing; L, landing; and T, trimmer.

To work the bottom easement to the proper curve, a piece of the torus moulding should be cut from the skirting (as Fig. 35), and laid on the string, marking its width as E F (Fig. 31), then the width of the skirting (9 in.) from A to C. Now draw a nice easement between the points A and E and cut it out. Now with a plane work a quirk, or groove, at a distance from the curved

edge equal to the width of the torus; finish the moulding with chisels and small planes. The torus moulding at the top of the wall-string is worked independently of the string, and nailed on as at A B (Fig. 32), as also is the moulding down the straight edge of the string itself.

After having taken the trouble to work the moulding around the easement, it is often continued, and the moulding worked solid throughout. If the job is worth the labour involved in working a solid moulding at the bottom, such a moulding should also be worked at the top If it is too expensive to work the moulding in the solid, it can be saw-kerfed and nailed on.

As before observed, it is very important that the depth of the trimmer-joist should be known, for from this is obtained the length of the square at the bottom of the newels. At Fig. 33 this will readily be seen, for if the square part A B had not been long enough between the points E and F, the turned drop at bottom would have been hidden by the plaster P.

Return flights are so called on account of their returning in a direction opposite to the bottom flight, as those numbered 13 to 16 in Fig. 30.

To set out the newels successfully requires, in the beginner, much careful attention and some little practice, or on receiving the newels back from the wood-turner they may be found to be useless, on account of the squares being wrongly placed.

Fig. 36 shows the newel as set out for the turner. Set up a vertical line indefinitely, then draw the pitch of the top edge of the newel-string, also the line of capping; then mark on the line the height and thickness of the handrail, and draw pitch-lines through it. At the distance of a step draw the newel, then the squares are determined as seen in Fig. 36, in which T denotes the parts to be turned; the length of the baluster is also obtained.

To set out the newel N (Fig. 29, on p. 41), first mortise it at the lower end to receive the string at I, Fig. 37, drawboring the string up to its shoulder. Now, from where the housing for the first tread joins the newel (6 in. from the bottom), measure upwards a distance equal to the height of the top of the handrail —in this case 2 ft. 7 in. (see E F, Fig. [illegible]). Set the bevel to the same angle as the stair-nosing makes with the floor-line, and apply it as shown at B, Fig. 38. Draw a line across the newel. Then, without altering the set of the bevel, draw a second line below this one and parallel with it, at a distance C A equal to the

thickness of the handrail. The bevel can be set from the pitch-board. The portions that will be occupied by mortises at the top and at the bottom ends of the newel are in this way defined,

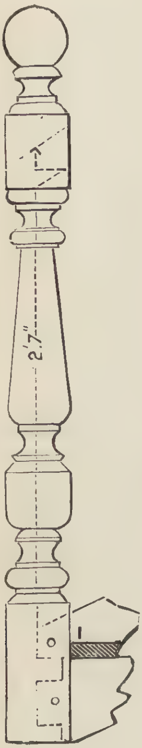
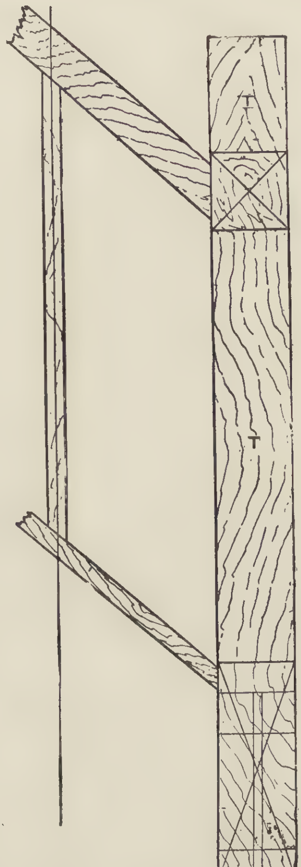


Fig. 37.—Well-shaped Newel.



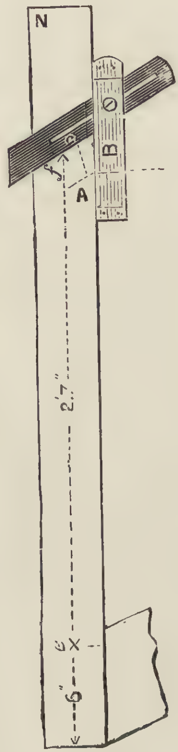


Fig. 38.—Newel for Mortising.

Fig. 36.—Setting out Newel.

and, after allowing an inch clear above and below, the remainder is available for being turned in a lathe. The patterns for newels

are not always alike, so the piece at top above the squared part must be allowed for according to the design. Fig. 37 shows a good and an inexpensive form of newel.

The second newel O (Fig. 29), higher up the flight, will require

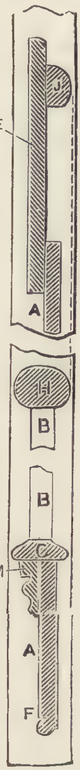


Fig. 39.—Newel with positions of Strings indicated.

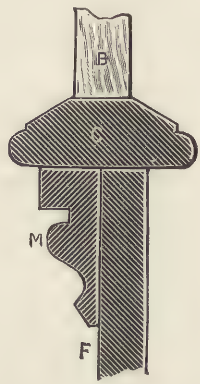


Fig. 40.—Enlarged View of Portion of Newel.

a much longer square part at the bottom, as it will have to take two strings. The bottom string should be fitted and the step to the landing marked (see L, Fig. 29, p. 41) from this line. The next step up the return flight should be measured upwards, and the top string also fitted. Now from the top step measure up the distance to the top of the rail, and set out the square as before. The third newel P (Fig. 29) will be treated in the same way, except that the bottom square will require to be only 12 in. from the floor level, allowing about 4 in. above at top and 3 in. for the drop at bottom. This newel also must have a square left at the top, to allow for the rail on the landing, which is 3 ft. 1 in. high, and a small piece should be turned between, or the square will be long and ugly. Fig. 33, on p. 45, shows an enlargement of this newel.

The strings are sometimes placed directly one over another in one vertical plane, but it is a much better plan to place them one

on each side of the centre line on the newel. Fig. 39 shows them so placed. The bottom portion of the figure shows F string, C cap, B B baluster, M moulding, and H handrail. The upper part has the two strings A and E, with half the rail at J shown. This method is superior to the other because of the facility it affords of placing half the rail on the return string, as shown at J in Fig. 39. The long rail at the bottom continues only as far as the top or return string, and the handrail then finishes down to the newel.

As seen in Fig. 39, the strings coming on each side of the centre throw the balusters B B on one side. To obviate this, prepare a cap C to nail on the top edge of the string, wide enough at the top to support the balusters, and at the bottom to cover the thickness of the string. A piece of moulding equal in thickness to another string is shown at M (Fig. 39). This part is shown enlarged in Fig. 40, B indicating the baluster, C the cap, M the moulding and F the string-board.

The landing newels are placed at the angle of the landing, to take the return rail. As only one square at the top is necessary, the turning may be a good deal longer than was the case in the third newel, P, Fig. 29, p. 41.

Handrails vary in height, but on the landings they must always be higher than on the stairs. Nosings are housed into the newels half-way on the joist, and form the top step. This is fully described in Chapter II. Balusters are of various kinds, both square and turned, and range from 1 in. to 2 in. in thickness. Handrails are made in a variety of forms, according to the class of stairs. It is largely a matter of taste. Spandrils are made in a number of ways ; the one shown in Fig. 29, on p. 41, is of a very common sort, being simply $\frac{3}{4}$-in. matchboard nailed on ; S P is the spandril ; and C C C shows a cupboard front made to receive a door, as by this means a very useful cupboard may be easily constructed.

CHAPTER IV.

STAIRCASE WITH WINDERS AT BOTTOM.

In the staircases previously dealt with, the going has not required special attention beyond care in setting out the number of steps so that they should not project beyond the given limits. The plan now to be worked on being strictly limited, the space for the going will require careful study, to enable the floor above to be reached in a reasonably easy manner. It will be found that this can only be achieved by introducing at the bottom a series of specially shaped treads, called winders (for definition see p. 10). Winders are placed in various positions. They may be formed at the top of a flight of stairs, or at both top and bottom ; or the whole of the lower landing (as in Fig. 41) is converted into winders, in which case they are called a half-space of winders. As before mentioned, winders should never be introduced when avoidable ; but they are often indispensable. The following examples have been taken as being representative of the various forms of winding stairs in common use at the bottom of flights.

The flight of stairs now to be considered (Figs. 41 and 42) is arranged to be placed between two walls, access being provided at the bottom at right angles to the going. Two doors, D D, Fig. 41, are at the top of the stairs, one on each side, and therefore it is necessary to form a landing. At first sight it might appear that winders could have been dispensed with, by leaving a space at the bottom similar to the landing at top, thus making a straight flight suffice. But on examination it will be seen that this arrangement would not answer, the going being so short that the great number of risers necessary would only allow of a very narrow tread to each step ; it is therefore necessary to employ winders.

As the narrowest space for foot-rest on the winders is of course round the newel, the winders must be made as broad as possible at this part. Many craftsmen strike out the winders from the centre of the newel (as at Fig. 43), but this is un-

desirable, the better plan being to keep back the fliers (straight steps are called fliers), so that the ends of the topmost winders may project a short distance beyond the newel (as at A, Fig. 44). At times it is also possible to have the lowest winder beyond the newel, as at B.

To set out the plan first draw the enclosing walls, with landing L (Fig. 41) and doorways in their respective positions; then draw the newel as shown at N, and draw the front edge of No. 4 riser 2 in. beyond the newel. Now draw the front edge of riser No. 1; then, with a radius of 15 in., strike an arc from the centre of the newel, and divide it into three equal parts; lines drawn through these points will give the front edges of risers Nos. 2 and 3. For purposes of measurement, the riser means the front vertical surface of the riser; it is shown dotted in Fig. 41. Now, as the space A F B C is occupied by the winders, it will be seen that the distance B to E is all the space at disposal for the fliers. Twelve having

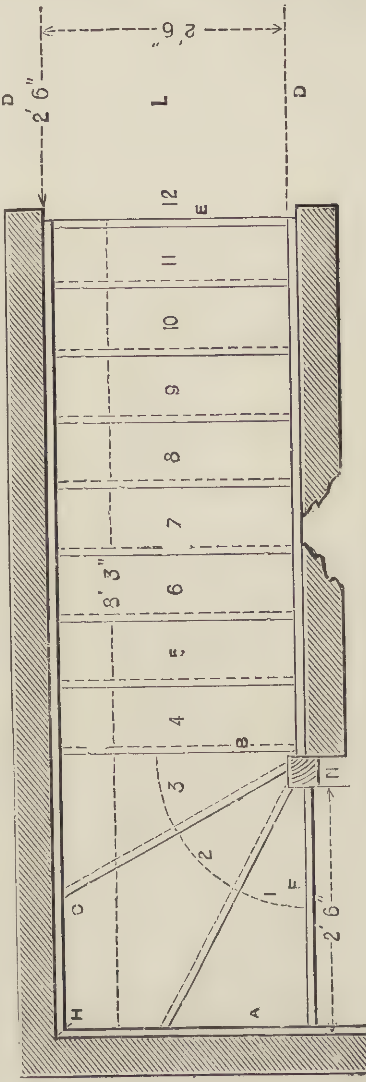


Fig. 41.—Plan of Staircase with Winders at Bottom.

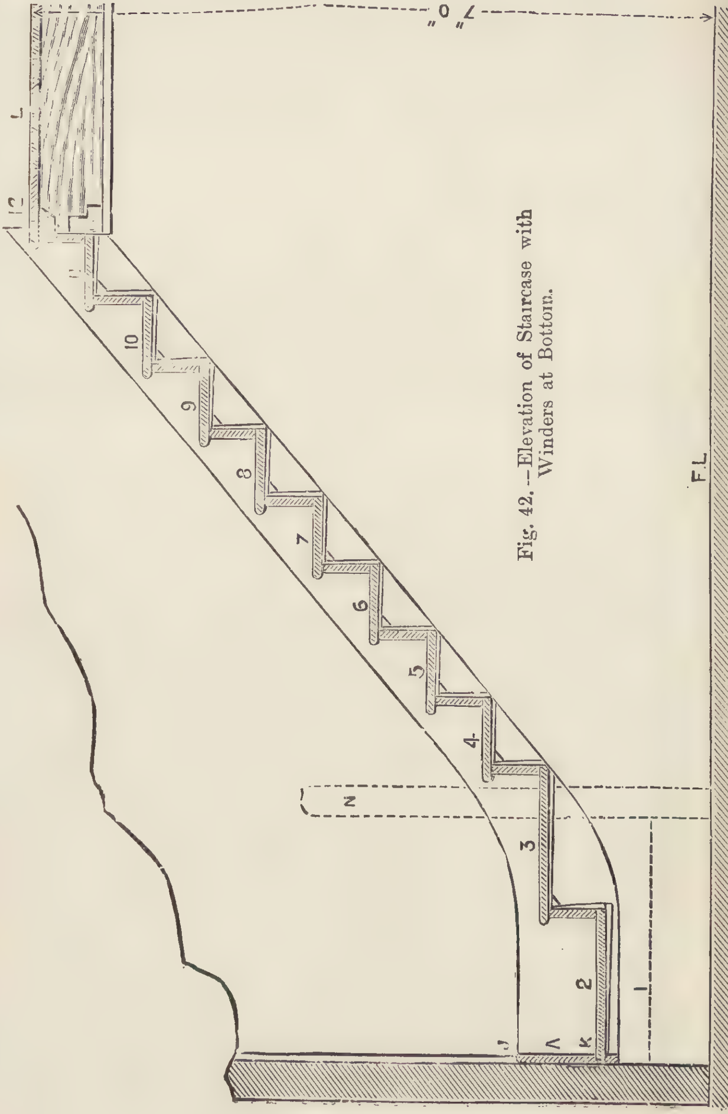
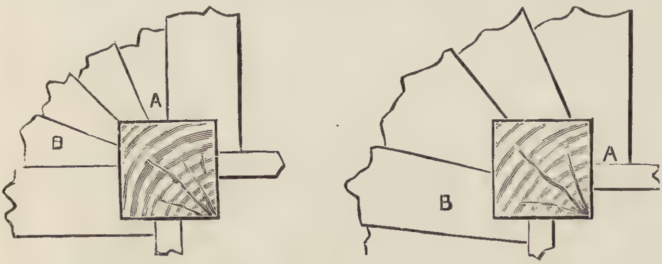


Fig. 42.—Elevation of Staircase with Winders at Bottom.

been decided on as the number of risers, both winding and flying, there will be eleven treads. The deduction of the three winders from this number leaves eight fliers, and so the space B to E must be divided into eight equal parts.

The elevation must now be drawn as described in Chapter II



Figs. 43 and 44.—Methods of Setting out Winders.

the only difference being with respect to the winders. The winders can be projected from the plan as before, and the easement on the string can be drawn as shown. As, in order to make a satisfactory job, the winders require careful sizing,

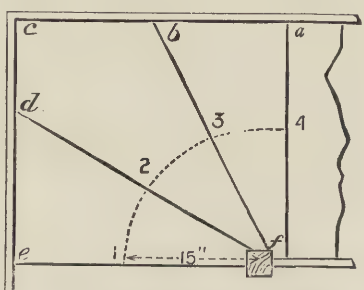


Fig. 45.—Plan of Winders.

it is necessary to make a full-sized drawing of them. A few boards, fixed together by ledges, will make a drawing-board sufficiently large, and on its surface the winders may be set out as at Fig. 45; the method has already been described in Chapter II., in setting out the plan. Having found the length necessary for the wall-strings by measuring from Fig. 41,

proceed to set it out with the pitch-board, starting at the top and working downwards until riser No. 4 is reached, as seen in Fig. 46. At right angles to this riser draw a line A B, equal in length to A B in Fig. 45. This gives the position of the edge of winder No. 3. Next draw riser No. 3 (B E), and draw a line E C the same length as from B to C on Fig. 45, thus obtaining one side of winder 2. Draw the line F C 1 in. beyond C, this being the thickness of the return string (Fig. 45), which goes along the wall at A (Fig. 41), and is jointed to the main

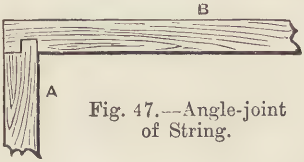


Fig. 47.—Angle-joint of String.

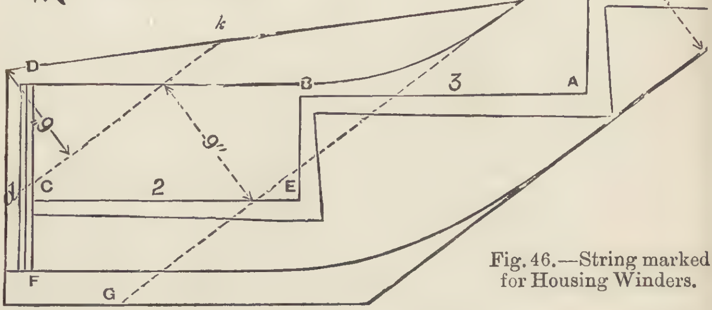


Fig. 46.—String marked for Housing Winders.

string as shown by Fig. 47, in which A denotes the lower string, and B the upper string.

Fig. 48 represents the lower wall-string that takes winder No. 1 and one side of No. 2. To set out this lower string, set a bevel B to a convenient angle, and apply it to the string as in Fig. 48, and make the lines J K correspond with points J K in the elevation (Fig. 42). Make C, Fig. 48, equal to C D, Fig. 45; draw the riser C *d*, and at right angles to this draw winder No. 1 making *d* K, Fig. 48, equal to D E in Fig. 45. It is obvious from Fig. 46 that one 9-in. board would not be nearly wide enough for the winders, and therefore several boards must be glued to the string with tongued joints, as at G H and D K, the dotted lines representing the joints. The easement on the string in

Fig. 46 should be made as shown, keeping the line as close as convenient to B, as otherwise the depth of the string above the second winder would be unsightly. This depth must be such

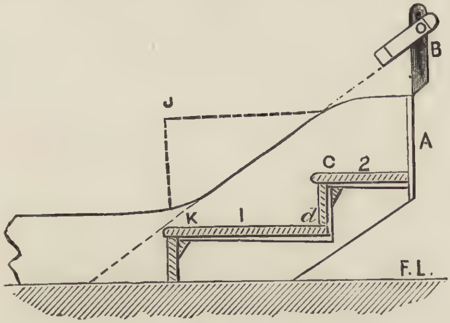


Fig. 48.—Lower Wall-string.

as to make the top line continuous with that of the string (Fig. 48), and that must form an easement to meet one lower down from the top of the skirting. In Fig. 48 A shows the tongue; B, bevel; and F L, floor-line.

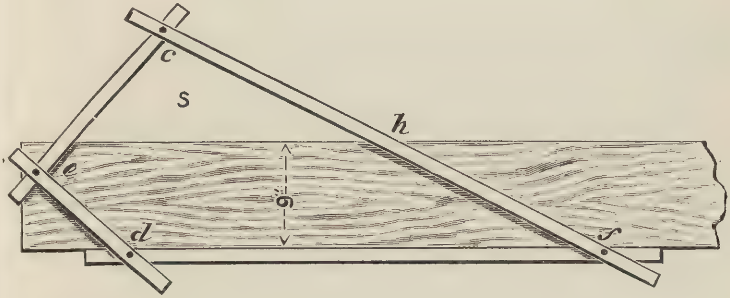


Fig. 49.—Jointed Template for Winders.

A mould or template for the winders will be very useful in saving both time and material. It can be made from four strips of deal, each about 1 in. wide and $\frac{3}{8}$ in. thick, screwed together at the angles as shown in Fig. 49. To apply the mould, lay the jointed strips on the lines F B C D in the full-size drawing

(represented by Fig. 45), and when the outsides of D E C H F, Fig. 49, coincide with D C B F, Fig. 45, screw the slips together. Allow 2 in. beyond the line D F (Fig. 45) for the nosing. Now place the mould on the board from which winder No. 2 is to be sawn (see Fig. 49, where the jointed template is represented as applied to a 9-in. board), mark round the outside of the template, and cut out the board to the marks. This will leave a board with a pointed or acute angle F D H (see Fig. 50), and this angular piece of board can be used for the piece required to make the other part of the winder S (Fig. 49), thus saving a good piece of stuff. The mould D E C H F (Fig. 49) must be altered in the same manner to fit the other winders, but these,

Fig. 50.

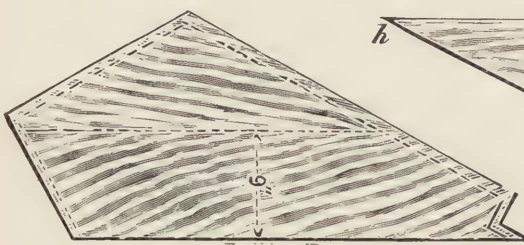


Fig. 51.

Fig. 50.—Piece left from Cutting Out Winder. Fig. 51.—Middle Winder.

having only three sides, will require only three strips to surround them, as reference to the drawing will show.

All the stuff having been cut off, the several pieces must be glued up with a tongue in the joint to make the complete winder, so as to render them less liable to part company in case they should happen to occupy a damp situation. When the glue is hard, the winders should be placed on the full-size plan, and marked for cutting to exact size.

It must be remembered that the lines A F, B F, D F, and E F in Fig. 45 represent the risers; therefore, 1 in. must be allowed beyond at the front of each for the nosing; the same allowance must be made at the back edge for the winder to pass under the riser above it; $\frac{3}{8}$ in. must also be added at the ends that are housed into the strings and newel. Fig. 51 shows the winder 2 (Figs. 41 and 42), cut to its proper shape, the dotted lines repre-

senting the edges of strings, riser and newel; it is made up of two parts (Figs. 49 and 50).

To house the treads and risers into the newel, start with the bottom riser R (Fig. 52), and cut a groove $\frac{3}{8}$ in. deep in the newel.

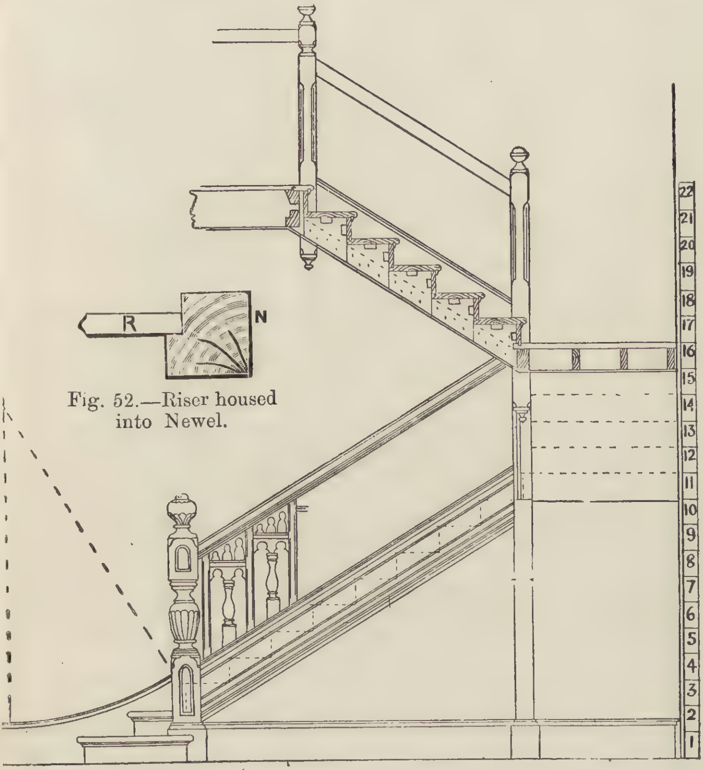


Fig. 52.—Riser housed into Newel.

Fig. 53.—Elevation of Newel Staircase with Well-hole.

Now mark the positions of the grooves for the other risers, placing each in its proper position, which is obtained from the full-size drawing. Then fit the treads in the same manner, and all that remains is to groove the outside string to correspond with the newel at the heights shown in Fig. 42, in

which the dotted line N is the newel. In Fig. 52, R signifies riser and N newel.

A point of great importance to the staircase-hand lies in the question—Can the stairs be placed in position after being put together in the shop? It is always better that they should be put together in the shop, if possible, as it saves a deal of time on the building; and it is often possible to arrange that this shall be done. In the present instance, if it is possible to lower in the stairs from above, the newel should be placed with its surface N (Fig. 42) flush with the outside of the string, thus affording no

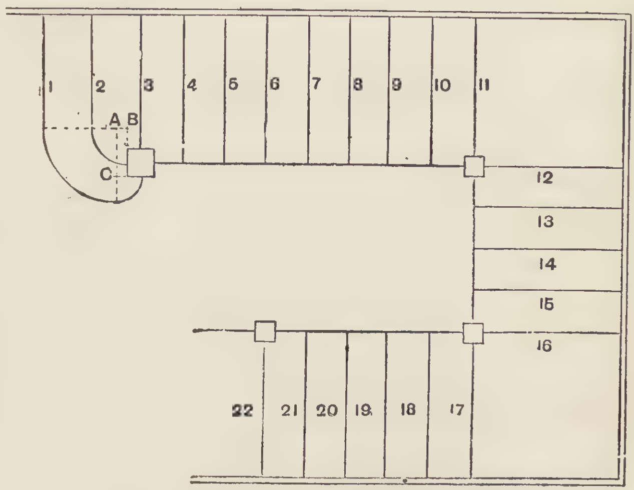


Fig. 54.—Plan of Newel Staircase with Well-hole.

impediment to its passage downwards. Failing this, the tenon on the end of the string should not be fixed into the newel. The wall string must be cut in two in a line with riser No. 4, then continued to the form of a bird's mouth. If this is done, the stairs can be placed in position in two parts—the winders in one and the fliers in the other.

Should any doubt exist in the mind of the reader as to his ability to make successfully a staircase with winders to a given plan, he is strongly advised to prepare a set of working drawings,

as here described, and to construct a model from them, working on a scale of, say, $1\frac{1}{2}$ in. to the foot ; by this means confidence will be gained. The modelling of the wall-strings would be sufficient, as the other string presents nothing beyond what has been attempted before. They might be marked out on a piece of stiff cardboard, as there is no occasion to make grooves for the steps ; only the level lines at top and bottom, with the proper easements, are wanted.

Figs. 53 and 54 give elevation and plan of a newel staircase, with open well-hole 3 ft. 6 in. wide, in a hall 10 ft. wide. Height from floor to floor is 12 ft. Staircases of this description are usually made in three flights, with two quarter-space landings, the second flight going across the well. Therefore the first consideration is, how many fliers this latter flight will contain, as it determines the going of all the fliers. The tread would be about 10 in. in examples of this character, so that dividing the 3 ft. 6 in. into four gives $10\frac{1}{2}$ in. ; this is taken as the tread. The next matter to consider is the rise. Assuming that twice the rise plus the tread equals about 23 or 24 in., there will be twenty-two rises of $6\frac{1}{2}$ in. full. There is usually a door under the second landing, which leads from the hall. From the floor to the top of this landing should be about 8 ft. 6 in. Therefore, looking on the storey-rod, the sixteenth riser is found to be the nearest to that which gives 8 ft. 8 in. to the top of the landing. A method of setting out suitable bottom steps for a staircase of this kind is indicated on the plan, Fig. 54, at A, B, and C, but this latter matter will be fully dealt with later.

CHAPTER V.

STAIRCASE WITH WINDERS AT TOP AND BOTTOM.

In the plan of the staircase now to be considered there is a somewhat restricted stairway to deal with, the going being so short that the use of winders at both top and bottom is imperative. It will also be noticed that a door D, Fig. 56, opens directly off the landing at the head of the staircase. The inclosing walls of plan and elevation being drawn, and the height for landing (L, Fig. 55) marked, it is found that provision must be made for thirteen risers, giving twelve treads. Now, it will be seen, on reference to the plan (Fig. 56), that in arranging for a straight flight it would be necessary to introduce a landing at the top and a space equal to a landing at the bottom. This, of course, cannot be done, as there would not then be sufficient space left between for the twelve steps. Nor can the necessary going be obtained by placing winders at the bottom only. There is no alternative, therefore, but to employ winders at both top and bottom. This course having been decided upon, the next proceeding is to set out the winders at the bottom. By introducing a step in front of the bottom newel N, Fig. 56, the going is lengthened by the breadth of that step. Draw the step No. 1, then draw the three winders, 2, 3, and 4, as described on pp. 53 and 54.

Set off the distance between the left-hand wall L W, and the newel P, Fig. 56, making it equal to the distance between the right-hand wall R W and the bottom newel, N. It is now seen that the door D on the landing L comes rather close to the nosing of the landing, making it dangerous to persons passing out. To remedy this, the nosing of the landing should be set forward as far as B. Set off the three winders, 10, 11, and 12, dividing them out equally as in former cases, and divide the intermediate part of the going into five equal parts as fliers, and the plan (Fig. 56) is completed. To finish the sectional elevation (Fig. 55), project the treads from the plan to intersect with the lines drawn for the risers as before, drawing the easements at the ends of the middle string. The dotted lines in the elevation represent the

two bottom steps and bottom newel, and at the top the landing, top newel, balusters, and handrail are shown similarly.

Make a full-sized drawing of the main wall string (Fig. 57). Draw A B, C D, E F, G H, all 9 in. apart, to represent the width of the boards of which the string is built up. At about the middle of the line E F (point K in Fig. 57) commence drawing

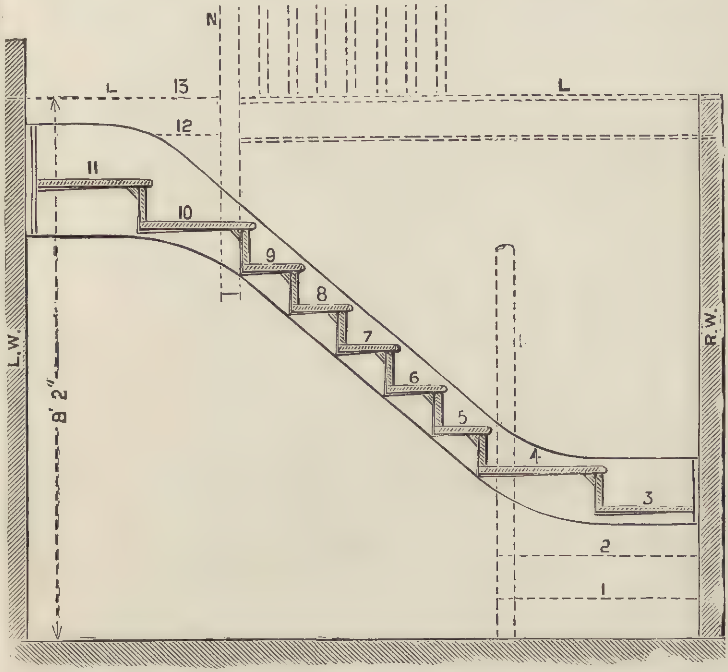


Fig. 55.—Sectional Elevation of Staircase with Winders top and bottom.

the zigzag line representing the housing groove for the ends of the steps. Point K is about 1 in. from the line E F. Measure the correct breadth and height of the treads and risers forming the fliers Nos. 5, 6, 7, 8, and 9, and set them off, to full size, along the string, as shown in Fig. 57. Draw the riser line of No. 4, and then complete the zigzag with Nos. 4, 3, 10, and 11, the measurements for which, as in previous examples, must be taken

separately from a full-sized drawing of the plan. The lines C G and B F, G J and B L, Fig. 57, are now drawn. Care must be taken that the distance between perpendicular lines drawn through G J and B L is the same as the measurement in the clear between the inner surfaces of the right and left walls in Figs. 55 and 56. The necessity for this will be seen on referring to the string in position in the elevation, Fig. 55, where the lines G J and B L (Fig. 57) coincide with the wall. Draw L A and J H parallel with F B and G C, draw A M and H N to complete the figure for sawing

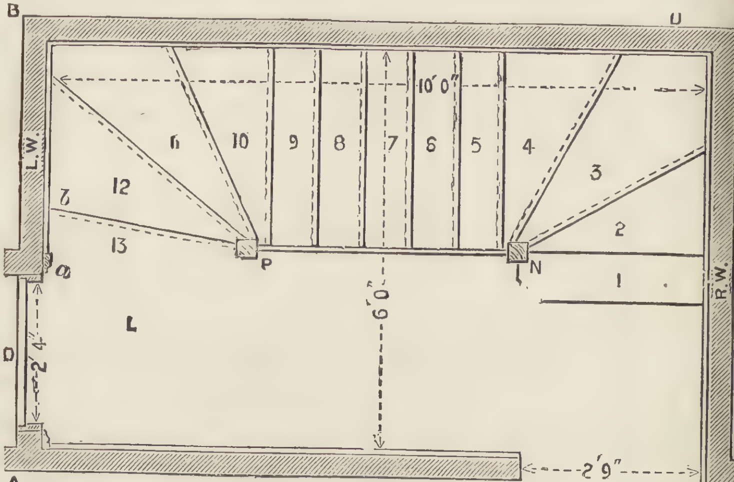


Fig. 56.—Plan of Staircase with Winders top and bottom.

out, and mark the curved dotted lines from E, M, N, and D to represent the easements. The string, as marked, having been sawn out, can be completely finished in the manner already described in previous cases, the joints being tongued and glued up as before described.

To set out the outside string, all that is necessary is to mark the shoulders S S (Fig. 58) and draw the housings, for the five fliers, with the pitch-board. The tenons are cut as shown, and draw-bored to the newels.

The elevation of the upper wall-string (Fig. 60) is obtained by projecting the lines of the winders from the plan (Fig. 56)

and marking the height of each riser obtained from the elevation (Fig. 55) to meet it. S is the string; T J. trimmer-joist; D, door, Fig. 59, the lower wall-string, is drawn in the same way, F L

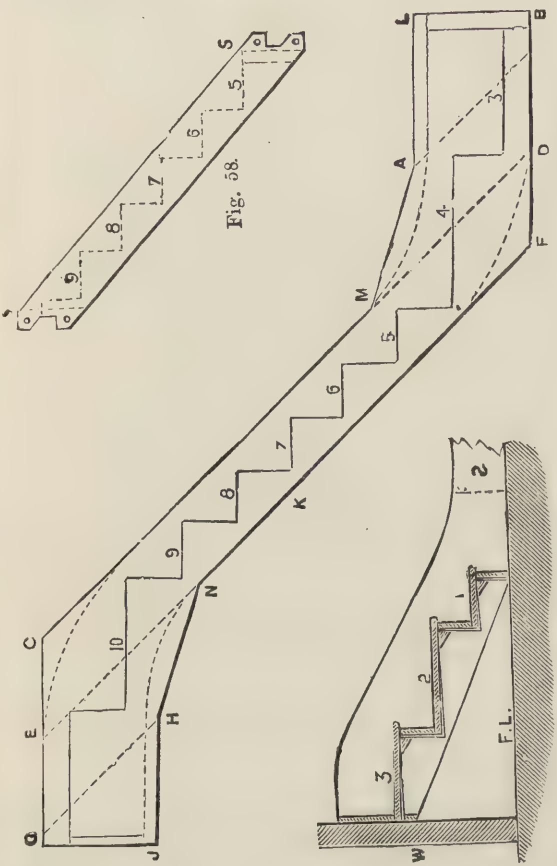


Fig. 58.

Fig. 57.

Fig. 59.

Fig. 57.—Wall String marked for Housing Steps. Fig. 58.—Outer String marked for Housing Steps. Fig. 59.—Lower End of Staircase.

being the floor-line and S the string. The method of applying the bevel for these two strings is described in Chapter IV.

When two or more boards have to be joined along their edges

to form a single surface of greater breadth, as in the case of the added pieces M D B L and E N J G (Fig. 57), it is necessary to tongue the edges together. Tongueing consists in making a groove, say, ½ in. deep and ⅛ in. wide in the two boards, along the edges that are to be brought together. Then a tongue,

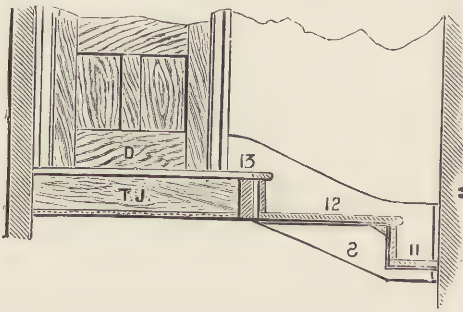


Fig. 60.—Upper End of Staircase.

consisting of a lath of wood, in this case 1 in. by ⅛ in., is inserted in the grooves; half of the width goes into each groove, the tongue and the edges of the boards being glued before being put together, and held in position by cramps until the glue has hardened. The peculiarity of a cross-tongue lies in its being cut

Fig. 61.—Cutting-board for Cross-tongues.

from a board in the manner shown in Fig. 61. The thickness of the board is the thickness of the tongue, which is sawn off in slanting slices from the much-bevelled end parallel with A B. Cross-tongues give a much stronger joint than is obtainable by the ordinary tongue in which the fibre lies lengthways.

To glue up this staircase, it is well to fix the fliers first, as previously described. The newels may then be joined, and the

winders, with the upper and lower strings, can then be glued and wedged into their proper positions.

Should the newels be so long as to prevent the staircase being carried into the building whole, the part continued above the winders may be cut off and added after the stairs are in place; a halving-joint and screws will fix the pieces together.

A square-mitred or canted step, as shown in plan at Fig. 63, is often used where the bottom step is brought forward beyond the string and newel; it is less likely to be in the way than a square-ended step. In this example the

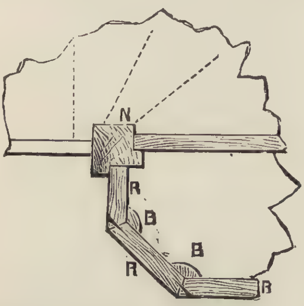


Fig. 63.—Square-mitred Bottom Step.

riser is in three pieces, R R R, cut to a mitre and nailed, blocks B B being glued in the angles at the back. The tread is nailed on the top, showing the same nosing margin (about 1 in.) at the front and end. N shows the newel.

Fig. 62 will give an idea of the manner in which the winders are housed into the newel marked P in Fig. 56. M represents the mortise into which the tenons on the string enter, and L the portions cut away to accommodate treads and risers. Housing to newels will be dealt with more fully in future chapters.

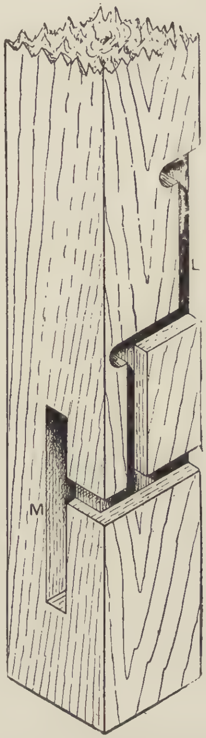


Fig. 62.—Newel grooved to receive Treads and Risers.

Easements should, when possible, be drawn freehand a

curve that satisfies the eye being all that is required. Another way is to lay a piece of flexible flat cane on the board to the curve that looks best. 2 lb. or 3 lb. lead weights, shaped like a sod-iron, hold the cane in position. (In Fig. 64, A B represents the curved cane, and W W W the weights.) By means of a pencil run along the outer edge, the curve to which the cane has been bent is drawn on the board underneath it. A third way is shown in Fig. 65, where two numbered straight lines correspond with the lines G C and C M in Fig. 57; these lines are divided into any even number of equal parts as at 1, 2, 3, 4, 5, 6, the numbering being in the order shown on the diagram—that is, the highest and lowest of the two series are nearest at the

Fig. 64. — Determining Easement Curve with Cane and Weights.

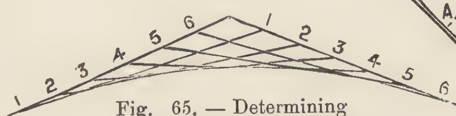


Fig. 65. — Determining Easement Curve by Intersecting Lines.

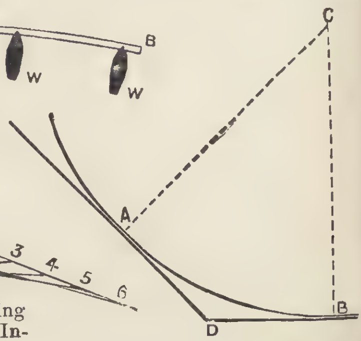


Fig. 66.—Drawing Easement Curve with Compasses.

point of the angle. Lines are then drawn from 1 to 1, from 2 to 2, and through the points where line 1 1 crosses line 2 2, and line 3 3 crosses line 4 4, etc., and where line 5 5 crosses line 6 6. These curves are drawn in freehand, the line so obtained corresponding with the dotted easement line below G in Fig. 57. Fig. 66 shows the fourth and simplest way. From D the point of the angle, A and B are found, equally distant from it. Line A C is then drawn at right angles to D A, and line B C at right angles to B D. The point where A C and B C intersect is made the centre of an arc having the distance to A or B as radius; the arc A B is the curve required. The distance D A or D B determines the roundness or flatness of the curve; the greater this distance is, the flatter is the curve.

CHAPTER VI.

STAIRCASE WITH HALF-SPACE OF WINDERS.

THE subject of the present chapter is a staircase with winders filling the half-space at the top, and $4\frac{1}{2}$ in. wall midway between the upper and lower flights. The amount of available space being much restricted, this subject is selected as a good illustration of some of the chief difficulties with which the staircase hand frequently has to deal.

The plan and elevation (Figs. 67 and 68) must be drawn as in all preceding examples, the winders and fliers being set out so as to make the best of the available space. It will be seen that six winders occupy the whole width of the stairway. The portion of the staircase thus occupied is known as a half-space of winders. The necessity for these winders will be readily understood when the measurements are taken.

Fig. 67 is a sectional elevation, which, as has been shown, is obtained by projecting lines from the plan to intersect with the tread-lines immediately in front of the main wall string. These lines 8, 9, 10, 11, 12, and 13 show the winders up to the landing. As there is a door on the landing immediately above the one at the foot of the stairs, the amount of heading is limited; consequently the trimmer T, Fig. 67, must be as close to the doorway as possible, in order to secure all available head-room. It will be seen that the distance in the present instance is 7 ft. 6 in. in a vertical direction from the bottom tread on the line C A, and 5 ft. 6 in. perpendicular to the nosing line of the treads on the line B A. The distance between A and B ought not to be less than 6 ft. 6 in.; but of course this is a matter that is governed by circumstances. The handrail is returned on the landing at right angles to the staircase, above the trimmer. The upper wall string (Fig. 69) and the end string (Fig. 70) are set out as before.

Fig. 71 represents the upper newel (A B C D, Fig. 68) developed. The four sides of the newel are to be marked off as shown by the dotted vertical lines between A B C and D, the four corners

representing the newel. A is the side against the wall, B C and D the edges lettered in plan (Fig. 68) to correspond.

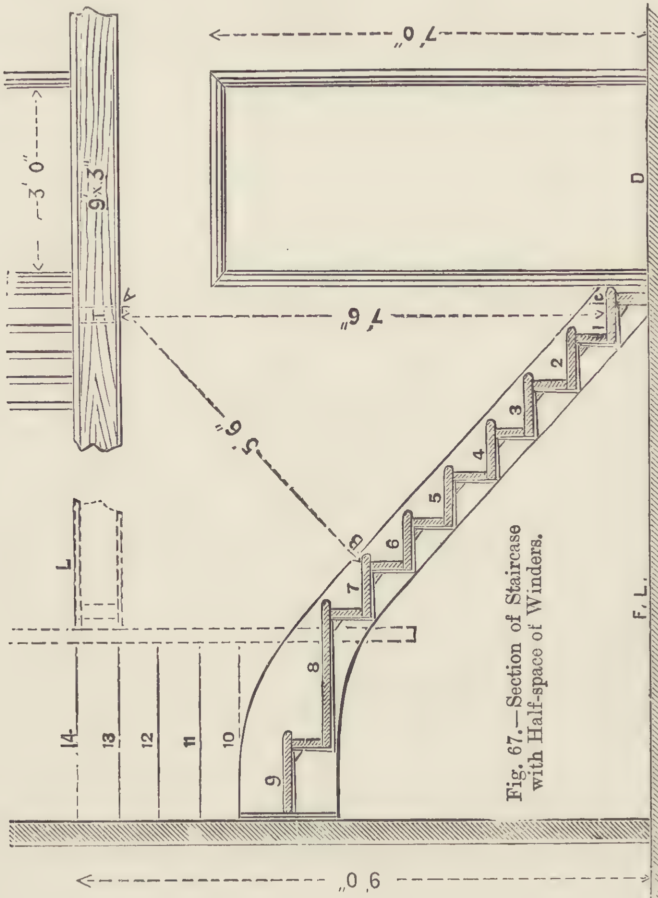


Fig. 67.—Section of Staircase with Half-space of Winders.

The plan of the winders should be set out to a large scale (say $1\frac{1}{2}$ in. to the foot). The breadth (going-wards) of each tread should be equal along a line drawn 15 in. from the centre of the

plan of the newel. In this way the space for receiving the foot is alike at the middle of each tread. Now develop the newel as at Fig. 71, first drawing the side A 6 in. wide; next draw the

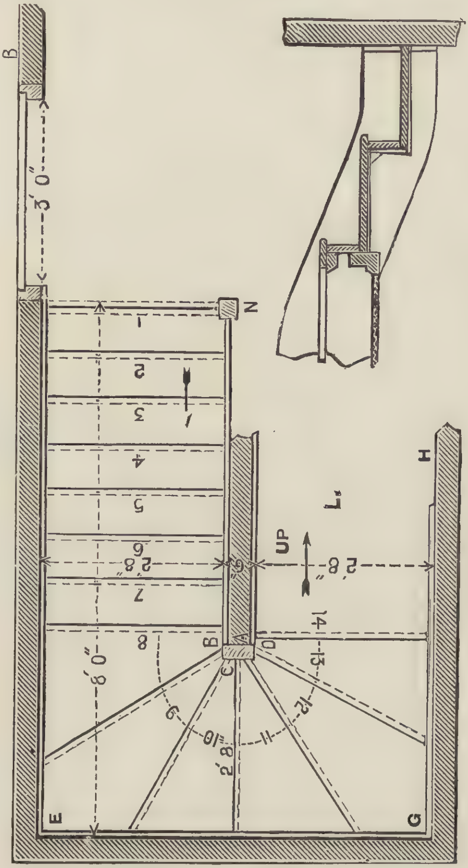


Fig. 68.—Plan of Staircase with Half-space of Winders.

Fig. 69.—Upper Wall-string.

space B 3 in. wide. Draw C 6 in. and D 3 in. wide. Now, at M, mark the mortise for the string and draw the first winder, No. 8, on the surface B. By taking the respective distances from the plan, and transferring them to the development, each winder can be marked

in its proper position—of course, marking the height of a riser between successive treads as they occur. If the drawing is set

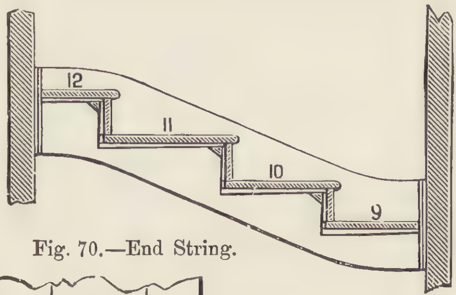


Fig. 70.—End String.

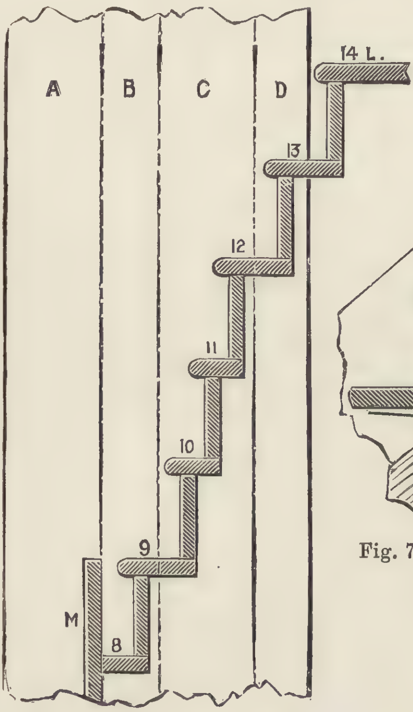


Fig. 71.—Newel with Sides A, B, C, D Developed.

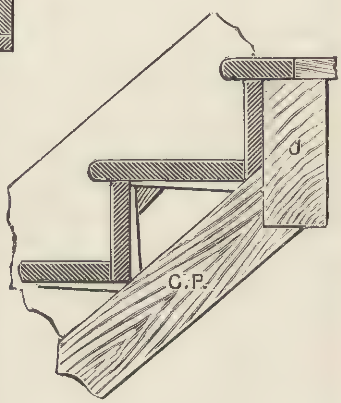


Fig. 72.—Stair Section showing Carriage-piece.

out on a piece of cardboard, and a knife lightly drawn along the dotted lines, the model can be bent to form a miniature newel,

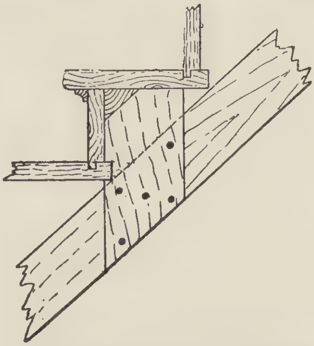


Fig. 73.—Support nailed to Carriage-piece.

showing the housing for each winder in its true position. This is almost as good practice as setting out a real newel.

Where there is no spandril under the stairs, a carriage-piece

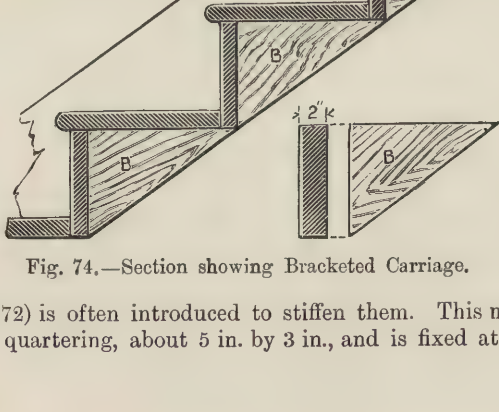


Fig. 74.—Section showing Bracketed Carriage.

C P (Fig. 72) is often introduced to stiffen them. This may be a piece of quartering, about 5 in. by 3 in., and is fixed at bottom

to the floor and notched at top to the trimmer J. This carriage-piece may be notched to admit the angular under-corner of each step. A better plan is to nail rough pieces on the side of the carriage-piece as shown by Fig. 73, letting them extend under each step. Fig. 74 shows another method often adopted. Brackets,

Fig. 75.—Saw-kerfs in Beading to assist Bending.

B, about 2 in. thick, are simply cut to the outline of a pitch-board, and nailed to step and riser underneath, midway between the strings.

As previously explained, mouldings of various kinds are usually nailed to the top edges of wall strings. All that is

Fig. 76.—Exaggerated Saw-kerfs in Beading.

required is a bead that will readily follow the lines of the easements. To facilitate the bending, many saw kerfs or cuts are made partly through the top or the bottom of the bead, according to the direction in which it is to be bent. This is shown at Fig. 75. The object of the saw-cuts is to remove a certain portion of the wood, and so allow the underside of the beading to close up on bending. Fig. 76 is somewhat exaggerated to how the principle. The subject of bending wood will be more fully explained in a future chapter.

CHAPTER VII.

STAIRCASE OVER AN OBLIQUE PLAN.

As will be seen from Fig. 78, the staircase in the present example is arranged over an oblique plan—that is to say, the outside (11 in.) wall is not at right angles with the walls forming the sides of the staircase. This often happens where the frontage line of the plot is not at right angles with the building. The stairs having been set out as described in the last chapter, the winders should present no difficulty, as they can be set out from one full-size drawing, which will, of course, have been drawn to the correct angle, as shown.

The sectional elevation (Fig. 77) can also be set out as before. The section being taken through the bottom flight on line A B, the portion of the winders cut by this line will also show as a section, as will the whole of the steps of the fliers below them, Nos. 1 to 7 inclusive. The upper portion will be as shown. Fig. 79, the end section on C D (Fig. 78) shows the housings for the winders to the string against the oblique wall. The method employed to set it out has been fully described in previous chapters.

The bottom newel N must be rather longer than the newels previously dealt with, on account of an easement on the rail, which terminates in a cap, as shown; the necessary length can be easily found by drawing the easement to the cap, which of course must rest level on the newel. Newel O may with advantage, in addition to supporting both top and bottom flights, extend downwards to the floor, thus forming at the same time a good support and a post to which the door for a cupboard may be hung.

It is a matter of common complaint that in ordinary houses insufficient cupboard space is provided. The space under a staircase is often wasted, whereas it might at very little cost be converted into a cupboard. In the present instance a cupboard, as shown in the side elevation, is formed by filling in the spandril (that is, the triangular space between the string and the floor) with 1-in. matchboarding under the bottom string, shelves S S S being fixed to the walls as is found most convenient.

The cap in this instance should be turned to correspond with the section of the handrail, which in the present case is elliptical, as shown in section (Fig. 80). Draw the section S, also the line E F representing the width of the rail; then draw the outer line of the cap B M L. Next draw the line D K, representing the

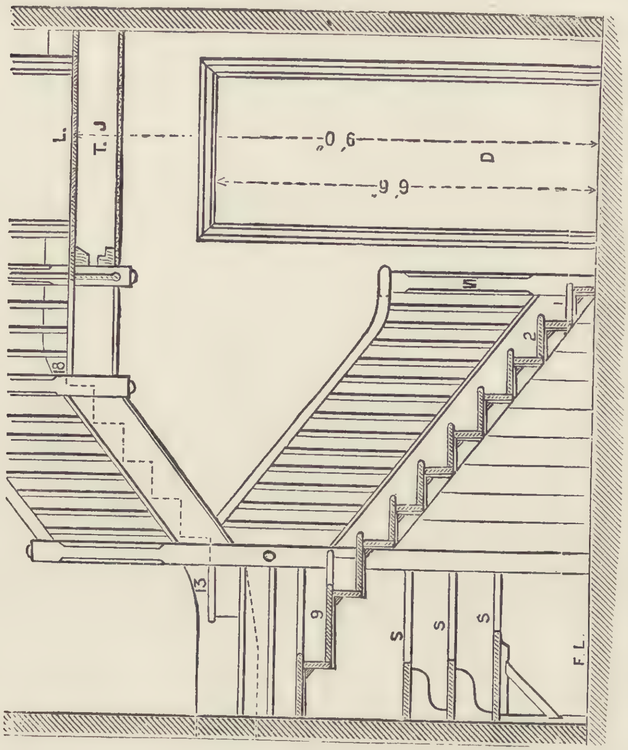


Fig. 77.—Sectional Elevation of Staircase over Oblique Plan.

width of the flat part of the rail, against which the balusters are fixed, and draw a line with the compasses concentric with the outer line of the cap, and distant from it the distance between lines E and D, to pass through D and K. Now from the point B, where the outer circle joins the line E, draw a line through the point D and produce it to A. Now, by drawing a line on the

other side through points L and K, cutting at H the one previously drawn, the lines of the mitre are obtained.

At Fig. 81 is shown a method of cutting this mitre on the cap.

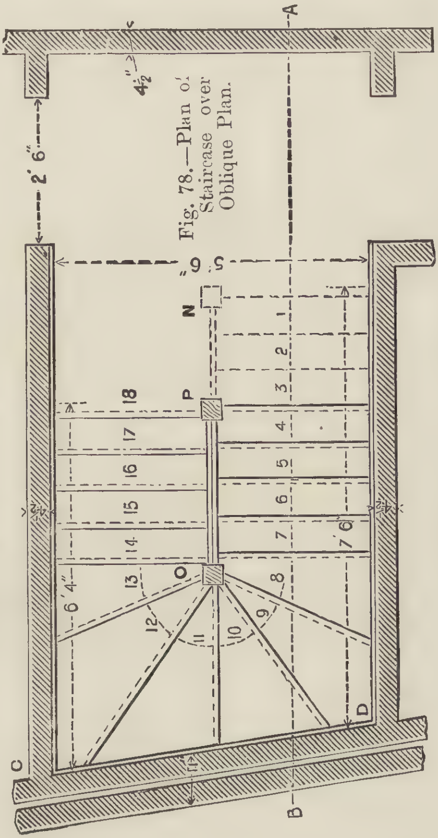


Fig. 78.—Plan of Staircase over Oblique Plan.

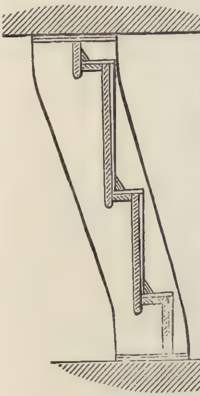


Fig. 79.—Section on Winders.

Plane up a piece of quartering, say about 4 in. by 2 in., and draw a line down the centre, as A A; on each side of this line set off the distance A C (Fig. 80), at B and C (Fig. 81). Now run a saw-cut S S down these lines. Having thus prepared the block, mark on the cap at any points on its circumference, as E F (Fig. 81), the extreme width of the rail as from E to F (Fig. 80). Now bore a hole through the block on the centre line, and pass through it a long screw into the back of the cap, thus fastening the two securely together, and place the point F on the cap opposite

the saw-cut S B, as shown, and run in the saw. Then turn the cap partly round until the point E coincides with the other cut S C, and run that in also, thus obtaining the mitre. Fig. 82 is a view of the block with the cap fixed and the saw in position, and

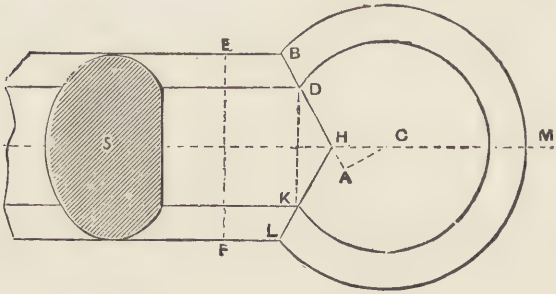


Fig. 80.—Joint of Cap and Handrail.

supplies a graphic illustration of the operation just described, showing clearly the cutting of the mitre on the cap. Although this is recommended as a good and by no means a complicated nor a troublesome method, it does not follow that it is the only

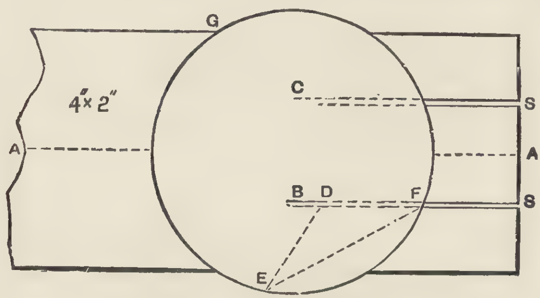


Fig. 81.—Mitre of Cap.

or even the most correct way of cutting the joint. B, Fig. 82, denotes the block and C the cap.

The joining of the rail and the cap is illustrated in Figs. 83 to 86. Fig. 83 shows the under-side of the end of the handrail and the cap, with two holes cut to a convenient depth to receive the

nuts on the handrail screw, and a hole (outline dotted) bored longitudinally in the centre of the cap and rail with a twist bit of suitable size to accommodate a handrail screw which, as shown

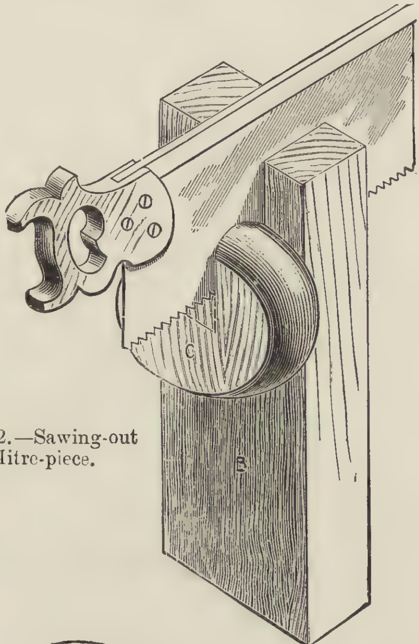


Fig. 82.—Sawing-out Mitre-piece.

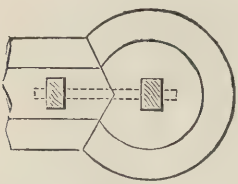


Fig. 83.

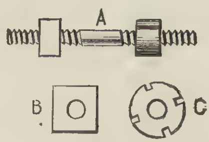


Fig. 84.

Fig. 83.—Underside of Cap and Handrail End. Fig. 84.—Handrail Screw and Nuts.

by A, Fig. 84, is a double-ended bolt having a square nut B of ordinary form fitted to one end, and on the opposite end a freely working cylindrical nut C, in whose periphery slots are cut.

The square nut B (Fig. 84) is placed in the mortise on the rail, and the bolt passed through the longitudinal hole and turned until it passes through the nut, leaving the other end to pass into the cap, as at Fig. 85. The round nut C is then dropped into the hole in the cap, and the bolt is pushed into it. The nut

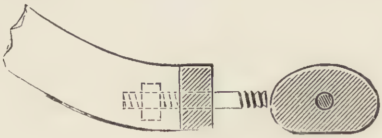


Fig. 85.

Fig. 86.

Fig. 85.—Side View of Cap and Handrail End. Fig. 86.—Punch.

having been started, the thin end of the punch (Fig. 86) is placed alternately into the slots cut in its edge, and gently driven with a hammer. By this means the nut is screwed up until the joint is sufficiently tight.

At Fig. 87 is shown a method of joining the cap to the newel. A pin is turned on the newel, and passed into a corresponding hole bored in the cap, into which it is glued and screwed.

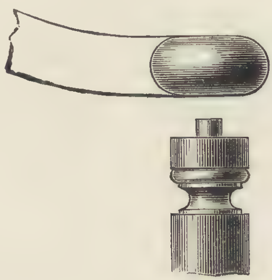


Fig. 87.—Fixing Cap to Newel.

In the staircases hitherto described both the outer string and the wall-string have been similarly trenched to accommodate the ends of treads and risers. The present chapter concludes the description of close-string staircases; future chapters will deal with stairs of a superior class, in which the outer strings will be cut, or notched out to receive the treads and risers.

CHAPTER VIII.

STAIRCASE WITH OPEN OR CUT STRINGS.

THE construction of staircases with open or cut strings will now be described. In a staircase with close strings, the ends of the treads and risers are housed into both strings—that is, are inserted into grooves or trenchings cut to accommodate them; but in an open-string staircase the steps rest in angular notches formed by cutting away the upper edge of the outer string. The

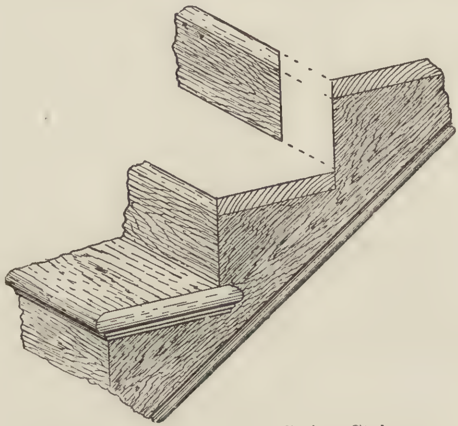


Fig. 88.—Joint for Open String Staircase.

ends of the treads, resting in these notches, project as much over the face of the string as the front portion does over the riser, and the nosing is returned across the end. At Fig. 88 is shown the joint used for the open string of a dog-legged or geometrical staircase, and the manner in which the string and risers are mitred and the former cut square through for treads to rest on.

It will be seen, by reference to the plan (Fig. 89), that the width allowed for the staircase is 7 ft.; so that, by allowing a

width of 3 ft. for each flight, two newels can be arranged on the half-space landing, which has a better effect than when one only is employed ; this will leave a "well" 1 ft. wide between the two flights.

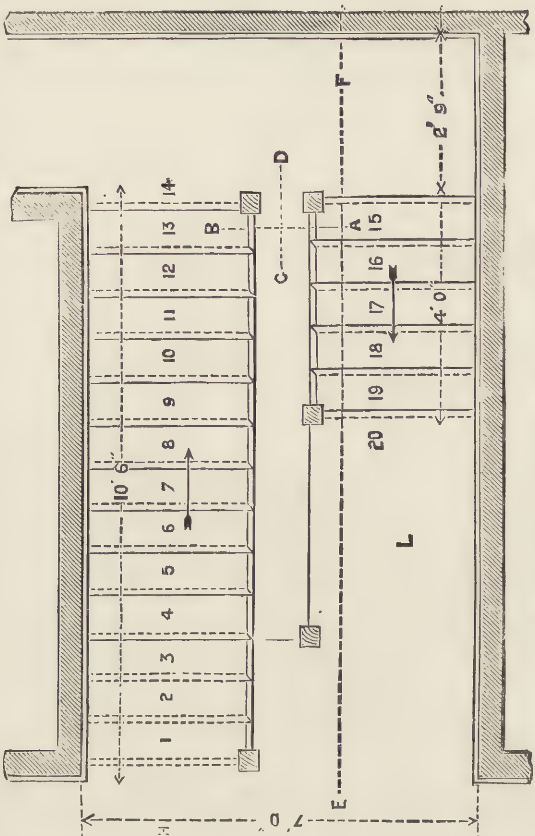


Fig. 89.—Plan of Staircase with Open Strings.

As will be seen from the plan (Fig. 89), the staircase is arranged at right angles to the hall H, and there is a passage exactly above it on the first floor ; from the half-space landing also, as seen, a doorway communicates with an adjoining room. This will, of

course, limit the staircase; and as an easy staircase is desired, it will be found, on dividing up the available space, that the number

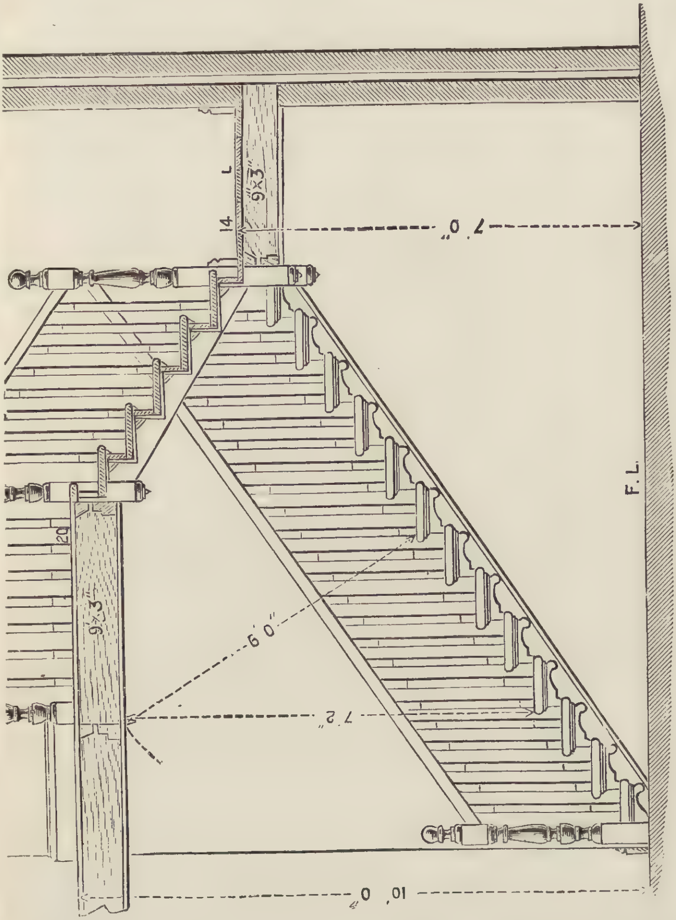


Fig. 90.—Sectional Elevation of Staircase with Open Strings.

of steps it is proposed to employ will allow no space for an easement of the strings; consequently a special moulding, to be described further on, must be worked.

Fig. 90 is a sectional elevation on line E F of the plan (Fig. 89). This can be set out by following the directions given in preceding examples, the only differences being that there are two newels instead of one on the half-space landing, and the string is "cut" instead of being "close."

The setting out of the newels for the turner will require special attention, as the appearance of the newels when in posi-

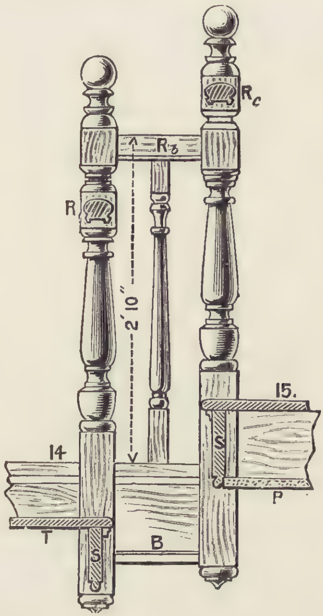


Fig. 91.—Hand-rail between Newels.

tion will depend on the care exercised in this particular. The bottom newel requires no special explanation ; it is set out as all others previously described (see p. 46). The newel at the top of the long string will require a little more care, as it has, in addition to the lower handrail, to accommodate another short one serving to connect the two newels on the landing. Before proceeding to set out, it will be necessary to cut the mortise for the string, and also to mark the height of the long rail (2 ft. 7 in.).

Newel No. 3—the one at the bottom of the upper or return flight—should be mortised; also mark on it the lines to denote the height of the upper handrail.

The arrangement of the handrail between the two newels on the half-space landing will be more readily understood by an examination of Fig. 91, which is a section on line A B in the plan (Fig. 89). The newel on the left-hand side of the illustration represents the one at the head of the long or lower flight; S S indicate the strings, for which mortises have to be cut; T, the tread immediately below the landing; and 14, the

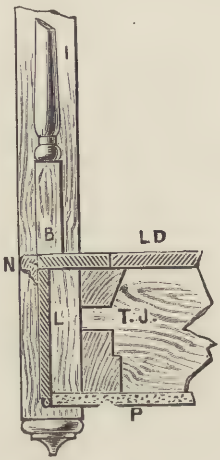


Fig. 92.—Section of Landing.

fourteenth tread, which is the landing itself. The newel on the right-hand side is the lower one of the upper flight, 15 being the first step up from the landing, as will be seen by reference to Fig. 89; P indicates the soffit plastering; R indicates the handrail of the lower flight, and R*c* that of the return flight; the position of these having been obtained, the height of the rail R*b* on the landing may be decided upon.

Fig. 92 shows a section through the landing taken on line C D (Fig. 89); T J is the trimmer-joist; L D is the landing; L is the lining, which is blocked out from the joist; B is the baluster, which is let into the floor-board; P is the plaster; N is the

nosing, which is worked to the same section as the nosings on the steps, and nailed to the edge of the flooring, as shown.

It has been previously explained that rails fixed either level or horizontal, as on landings, should be higher than those fixed on the pitch or on the slant of a staircase; but the distance between the newels being so small, no regard need be paid to this rule in the present instance, as the placing of the handrail at a height of 3 ft. 2 in. from the landing would necessitate the employment of a square portion of such a size as to be unsightly. By allowing the rail to be 2 ft. 10 in. above the level of the landing, some turning may be arranged for between the rails.

The square part under the landing is much longer on one newel than on the other. The provision of a long square portion on the bottom newel is a necessity in order to take the string S, Fig. 91, but this necessity does not exist with the top newel. The square portion is therefore continued about 1 in. below the bead B, and finished off with a turned drop, which may be about $2\frac{1}{2}$ in. long.

Before mortising the newels for receiving the tenoned ends of the strings, the size of the balusters should be determined. They are made in sizes ranging from $1\frac{1}{4}$ in. to $2\frac{1}{4}$ in. square; but as $1\frac{3}{4}$ in. is the average size, it will be presumed that balusters of this size are to be used. Draw parallel lines showing the newel full size (see Fig. 93), and in the centre of the newel draw the baluster B B; then in a line with the outer edge of the baluster draw the line B T, and parallel with this another line to indicate the thickness of the bracket under the outer end of the tread, which is $\frac{3}{8}$ in. This bracket, as will be explained later, is nailed on the face of the string; consequently it follows that the string S itself should be set off on the inside of the bracket. The distance from a to b will give the distance in from the edge of the newel to gauge for the mortise, the tenon for which should always be cut with a bare face. In Fig. 93, N denotes the nosing, C a beading beneath it, and T the landing.

In setting out the cuts or notches in the strings, it must be borne in mind that the treads are fixed to the top of the portion cut away to receive them. In previous examples it has been the practice to set out the strings by the top of the tread, so that it must now be remembered that the thickness of the tread ($1\frac{1}{4}$ in.) must be allowed in setting out the line to cut to. The cutting of the riser must also be taken into account, and details of this and all other important parts will be given in the next chapter.

Commence to set out the cut-string from the bottom edge. The pitch-board (see Fig. 18, p. 33) having been prepared as shown at Fig. 94, the distance from *a* to *b* should be made equal to the combined depths of the carriage-piece and plaster; the

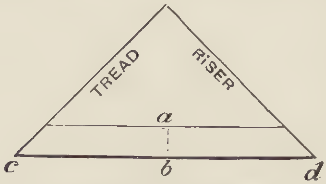


Fig. 94.—Pitch-board.

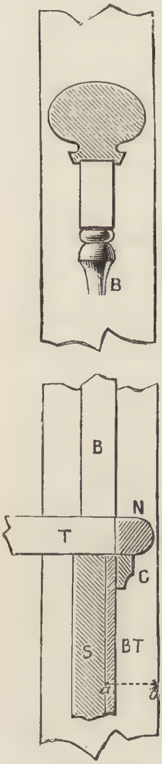


Fig. 93.—Setting out Position of String on Newel.

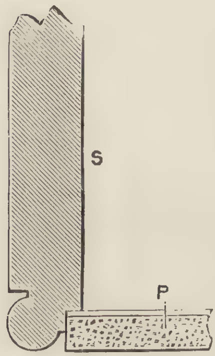


Fig. 95.—String rebated to receive Plaster.

guide is screwed along the edge C D. Fig. 95 is a section of the lower edge of the string S, Fig. 91, rebated to receive the plaster P, below which is the carriage-piece. In Fig. 90, the arc struck with a radius of 6 ft. with the nosing of tread No. 8 as centre gives the position of the trimmer's lower edge on the landing.

CHAPTER IX.

CUT-STRING STAIRCASE WITH BRACKETS.

In the preceding chapter an open-string staircase with two newels on the landings was exemplified. The various processes in the construction of a flight of stairs of this kind require very careful attention, and in the present chapter the methods usually employed to ensure a good job will be described.

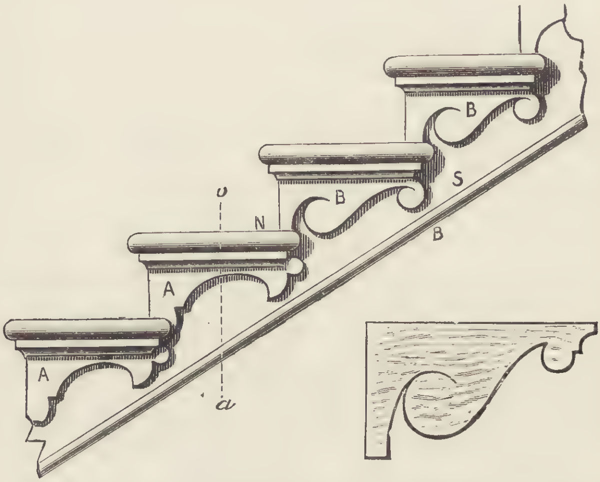


Fig. 96. Fig. 97.

Fig. 96.—Elevation of Cut-string Staircase. Fig. 97.—Alternate Design for Staircase Bracket.

Fig. 96 shows the elevation of part of a cut-string staircase complete with nosings and brackets. At A A is shown a form of bracket that is often adopted where economy is necessary. It is easy to work, and allows the nosing to be "returned in itself." A section through *a b* is shown at Fig. 109, p. 92. Brackets are usually about $\frac{3}{8}$ in. thick, and are fixed immediately under the treads, which project over the string and finish flush with the

face of the brackets. At B B a different form of bracket is shown, and this is superior to that shown at A A. These brackets B B, finishing each in itself, require the nosings to be mitred, and to return $\frac{3}{8}$ in., this being the thickness of the brackets, which do not extend under the nosings at this point; so the nosing must be fastened to the string itself. Fig. 97 shows, on a larger scale, another pattern of bracket. It is a good plan to plane up to the right thickness a piece of board (pine for preference, because it is easy to work), and to saw the brackets out of it.

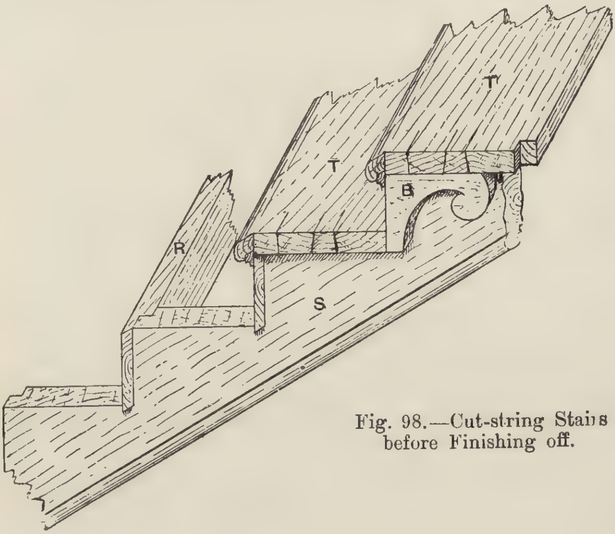


Fig. 98.—Cut-string Stairs before Finishing off.

A sufficient number of brackets having been sawn out, cramp them together, and work up with hollow and round planes of various sizes, finishing up with glasspaper. This method is to be preferred to working each up singly, as it takes less time and ensures uniformity of shape. Of course, parts of bracket B cannot be worked in this manner, as the planes will not work far enough into the eye of the scroll, but this part can easily be worked after the rest has been finished and the pack has been uncramped.

Fig. 98 is a general view showing various stages of the finishing off of four steps. The lower portion shows the string itself, marked S, notched or sawn out ready to receive the steps.

T illustrates the tread, and R the riser with its mitred end projecting the thickness ($\frac{3}{8}$ in.) of the bracket B, which is mitred to it, over the string. The step second from the top shows the tread extending over the outside of the string; and the upper step shows the bracket B nailed in position.

In setting out the width of the treads, it must be remembered that they extend $\frac{3}{8}$ in. beyond the thickness of the string, also $1\frac{1}{4}$ in. for the returned nosing; this $1\frac{1}{4}$ in. (the thickness of the tread) is usually taken as the right amount to allow to project over the riser. The treads are now to be set out for the return nosing by squaring them across, at a distance from the end equal to the projection of nosing; they are then marked for the mitre

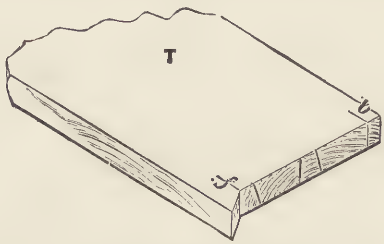


Fig. 99.—Shape of Tread.

with a mitre square or a bevel set to an angle of forty-five degrees, after which the piece is cut out clean, leaving the tread as at Fig. 99. The tread must now be ploughed on the underside parallel with the nosing to a depth of $\frac{1}{4}$ in. with a $\frac{1}{2}$-in. plough-iron; this is to receive the piece ($1\frac{1}{8}$ in. by $\frac{1}{2}$ in.) for the cove.

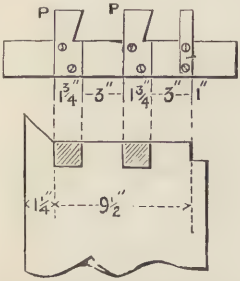
In preparing for the balusters, it is first necessary to make a mould or template by which to mark the treads. Plane up a piece of stuff about 14 in. by 2 in. by $\frac{3}{8}$ in., and two pieces equal in width to the size ($1\frac{3}{4}$ in.) of the balusters and 2 in. longer than the thickness of the tread. Cut in one end of each of these pieces a dovetail P P, Fig. 100, equal in thickness to the treads. Now from the pitch-board obtain the width of the tread, from the inside of the nosing to the outside of the next riser above, which may be taken as $9\frac{1}{2}$ in.; now deduct the thickness of two balusters ($3\frac{1}{2}$ in.) from this, dividing the remainder (6 in.) into two parts. Fig. 100 will illustrate what is meant.

At a short distance from one end of the 14 in. strip (Fig. 100)

screw one of the dovetailed strips as shown to the left in Fig. 100. Now mark 3 in. from this, and screw on the other dovetailed piece; again mark off 3 in., and inside the last mark fasten on a piece of plain wood 1 in. wide. These pieces may be of any thickness.

To apply the template, place it on the end of the tread, as in Fig. 101, with one edge of the outer dovetailed strip close up to the mitre, which is better seen at F (Fig. 99). Outline the dovetails with a pencil, and square the marks down the face of the tread for a distance of $1\frac{3}{4}$ in. (see Figs. 99 and 100).

The next proceeding is to cut in for the balusters. This is



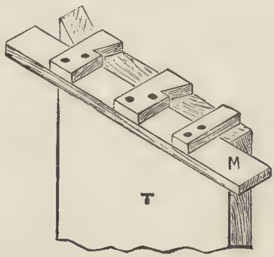


Fig. 100.—Template for Marking Treads. Fig. 101.—Marking Ends of Treads with Template.

managed by running a saw down the marks made on the face of the tread, care being taken not to pass beyond the $1\frac{3}{4}$ in., or it will show after the balusters are fixed. The saw-cuts are shown at Figs. 98 and 99, the former showing the top-side and the latter the under-side of tread. The portions to be cut away are next partly cut through on the under-side with a mallet and chisel; the pieces will have to be completely cut out when the balusters are fixed, after the stairs are in position. The small piece *b*, Fig. 99, is cut out, to allow the tread to pass over the string in front of the riser above, as this gives the width of tread.

It is obvious that the risers must be at right angles to the treads, and every care must be taken to ensure this result; hence the use of the cradle shown at Fig. 102, which is a very useful appliance for glueing up the treads. To make the cradle, prepare two pieces of stuff R R, about 3 ft. long, 4 in. wide, and $1\frac{1}{2}$ in. thick, and two similar pieces L L. Now cut two other

pieces as B B, sawing out the notches *a a* to admit the nosing and cove. Nail R R and L L firmly together, and let the pieces B B

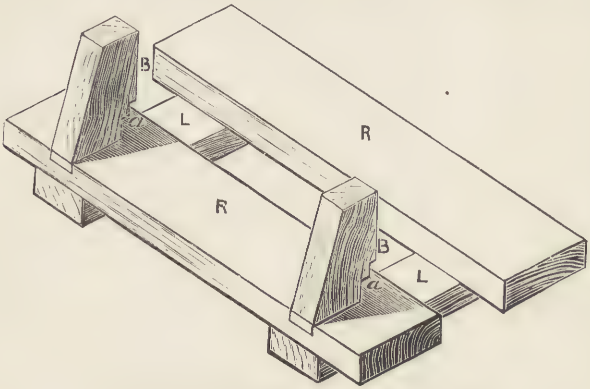


Fig. 102.—Cradle for Gluing up Treads.

into R, as shown, and nail them there, making sure that the faces B B are perfectly square with R R.

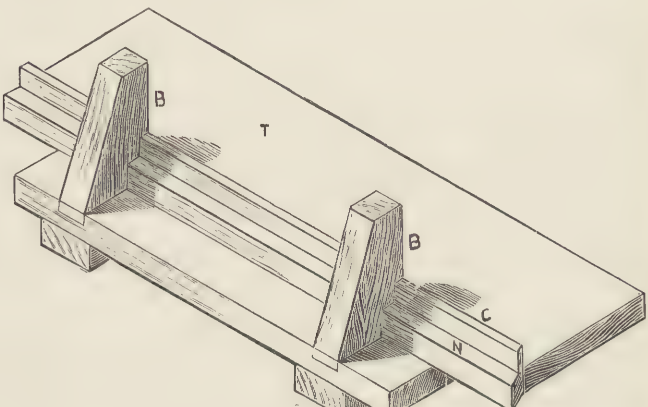


Fig. 103.—Method of using Cradle.

Having first glued in the pieces designed for the coves, place the tread, face downwards, on the cradle, as at Fig. 103. Now fit

each riser in its place by shooting the edge until its face coincides with B B. Fit three blocks in at the back, making sure that they fit there quite square, as on this depends their usefulness. Having fitted all the risers, glue them and the blocks behind them to the tread, and place them on one side to dry. The risers

Fig. 104.—Return Nosing for Cut-string Stair.

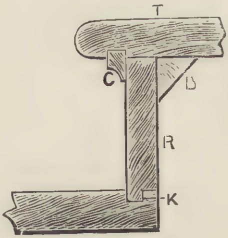


Fig. 105.—Section showing Tongued Riser.

must then be worked to the width ascertained from the pitch-board. In Fig. 103, T is the tread, C the cove, and N the nosing.

The nosings should be worked with the nosing-plane illustrated

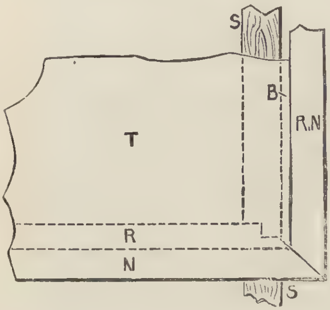


Fig. 106.—Part Plan of Step.

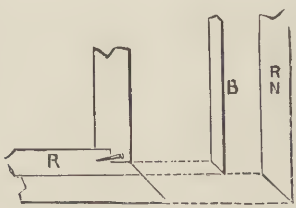


Fig. 107.—Details of Step.

by Fig. 23 and described on p. 36; the coves are also worked with a special plane of similar construction, but having a differently ground plane-iron. The formation of the return nosings will depend on the kind of bracket selected; they should be worked as shown in section by Fig. 104—that is, the nosing and cove in one piece, and not in two as shown in Fig. 105. If the bracket is to be as A (Fig. 96), the nosing must be returned in

itself; if as B (Fig. 96), a mitre is cut on each end, and a small piece is glued on the return.

Fig. 105 is a section of a step when worked; T is the tread, C cove, B block, and R riser. The riser is sometimes tongued into the next tread, as shown at K. At Fig. 106 T is the tread, S the string, N the nosing, R N return-nosing, R the riser, and B is the bracket, which is between the string and the return-nosing. R (Fig. 107) is a plan of the riser as cut out for string and bracket; it is cut in this manner (and the string to correspond) to prevent the necessity of making the string to an exact thickness. Fig. 108 shows a portion of a tread with the lower ends of two balusters in position: T tread, B baluster, *b* bracket, N

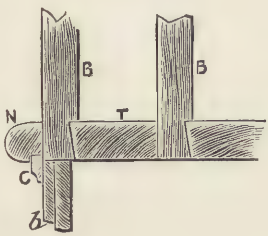


Fig. 108.

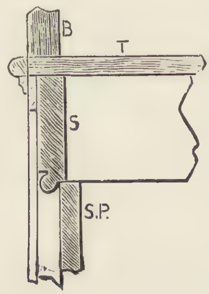


Fig. 109.

Fig. 108.—Step section showing Balusters.—Fig. 109.—Section through Step of "Cut-string" Staircase.

nosing, and C cove. Fig. 109 is a section taken at *a b* (Fig. 96), S string, S P spandril, T tread, and B baluster.

In putting open-string staircases together, it is necessary to guard against the chance of wedging them up askew; to prevent this fault it is advisable to place each tread in its proper place in the wall-string, and to screw each riser firmly into the next tread below. If this is properly done, and the ends of the steps are all kept even, it is scarcely possible for them to be out of alignment. Having wedged the steps into the wall-string, the cut-string should be placed in position with a piece of stout quartering against the nosings. Cramps are then applied to draw the string tightly up into each step. Some staircase hands prefer to fasten the ends of the treads and risers to the cut-

string first, then up-end into wall-string, and wedge up. It is claimed that this method leaves no doubt about the work being square, that it takes less time and is easier of execution. It will be seen that the risers being placed on top of the treads, the cramp is sure to draw the steps firmly down. The string can now be nailed through the face into each riser, as shown in Fig. 107; the bracket will cover up the nail-heads. A few nails can also be driven aslant through the treads into the risers. Blocks should be glued at the back of each step against the string; one of these, often made by splitting a piece of square timber, is shown in Fig. 105, marked B. The brackets should now be fitted and bradded to the string, care being taken that they shall be level or flush with the surface of the treads projecting over the string, as the return-nosings will be nailed on top of these. The return-nosings should not be at first fixed permanently, as they have to be removed to fix the balusters, but by two nails driven partly home, so that they may be easily withdrawn with pincers.

CHAPTER X.

OPEN-STRING STAIRCASE WITH BULL-NOSE STEP.

THE method of setting out the plan and elevation having been fully explained in former chapters, it is unnecessary to refer again to this part of the drawing for that purpose. At Fig. 110 is shown a step at the bottom, which is known as a bull-nose step. Many kinds of steps are employed, amongst them being the "bull-nose," as here illustrated; "commode," or two steps placed one on top of the other; and "curtail." The first will be described in the present chapter; a description of the curtail step will be found in Chapter XII.

The accompanying illustrations, with description, show a method of constructing a bull-nose step, which takes but little, if any, longer time to construct than a mitred or canted one, and which, when completed, looks much better than either, although, of course, it does not make such a good job as a veneered step. First set out the step full size on a board, as shown to a reduced scale in Fig. 111. Having cut off to the requisite length and carefully planed up the riser, which must be clear and free from shakes and knots, etc., at the end to be bent, set the riser on the board, and mark as shown at A. Then, with a marking-gauge set to $\frac{1}{8}$ in. bare, gauge the riser on both edges from the face side. Square the mark across, and with a panel-saw cut in the back side down to the gauge mark, taking care not to go too deep, and keeping the same depth right across. Now press the cut together, and mark the distance the riser can be bent round with the one cut at B. Then remove the riser, and set the compasses to this distance B D, and ascertain how many such distances there are round the inner line from A to C. This will give the number of cuts required at the distance B D apart.

It is advisable to try the riser at every two or three cuts made, as it will bend better with frequent testing than if left till all the cuts are made. To keep the riser in position while trying and securing it, tack two strips on the board, as shown in position at E E (Fig. 112); also a piece F at the end of riser, in preparation for bending. Run good hot glue into all the cuts;

set the riser on the board, and secure it temporarily with a piece of wood about 18 in. long by $1\frac{1}{2}$ in. square, cut to the shape shown in position at G; take care that all the saw-cuts in the riser are up close. A piece of canvas glued round inside is a

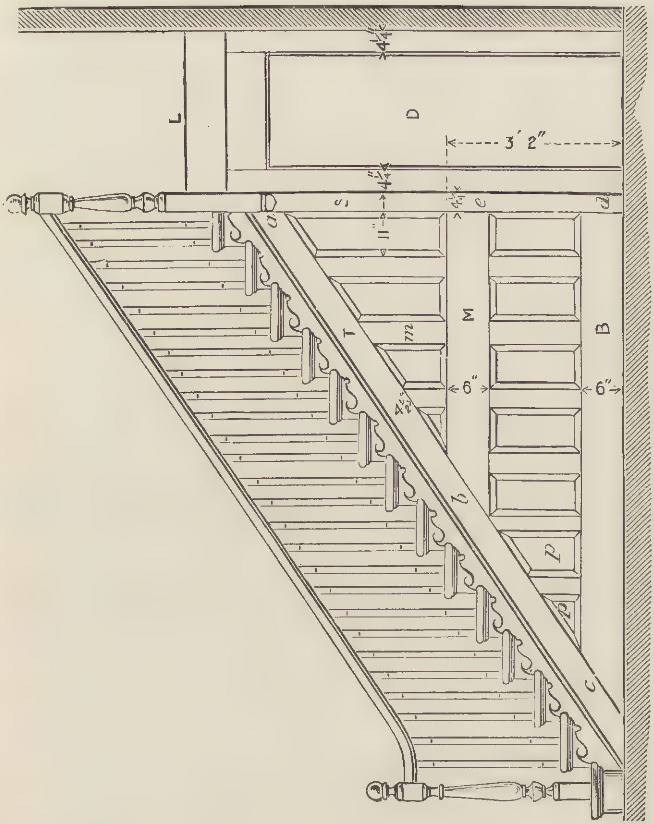


Fig. 110.—Open-string Staircase with Bull-nose Step.

great improvement, although not absolutely necessary. Now cut two blocks of the shape shown at H (Fig. 113) out of $1\frac{1}{4}$-in. stuff, and screw them on inside to riser, as shown in Fig. 113; screw the top block the proper distance down from top necessary to receive the scotia cover, which must be screwed to the block

with three screws. The notched piece G, Fig. 112, can now be removed, to answer the same purpose again if required; then well

Fig. 111.—Setting-out Bull-nose Step.

sandpaper the bull-nose round the way the grain runs. The scotia and tread can be prepared in the ordinary way. The blocks,

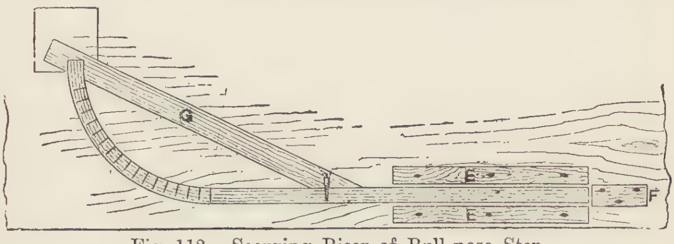


Fig. 112.—Securing Riser of Bull-nose Step.

scotia, and tread can all be marked with the riser, as it can be handled all the time, thus obviating any necessity for getting

Fig. 113.—Riser and Block of Bull-nose Step.

out a pattern. Be careful to saw all the riser cuts the same depth, to prevent cripples in the bend. If these instructions

are carefully followed, a well-shaped bull-nose step will be quickly made.

Description will now be given of another method of making

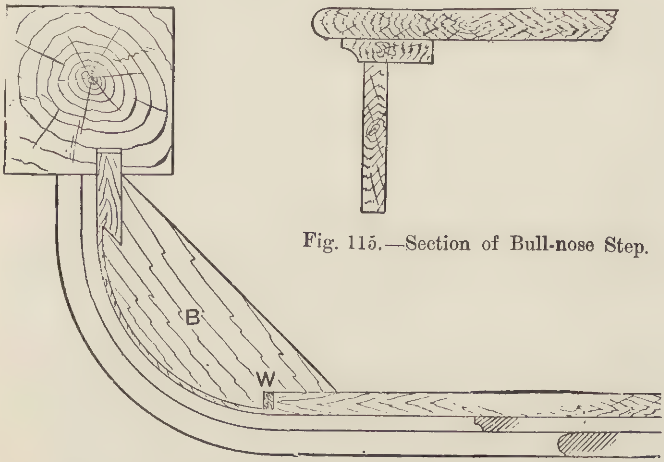


Fig. 115.—Section of Bull-nose Step.

Fig, 114.—Alternate Method of Fixing Bull-nose Step.

a bull-nose step; so as to obtain a correct idea of the work necessary to complete a step, it is preferable always to

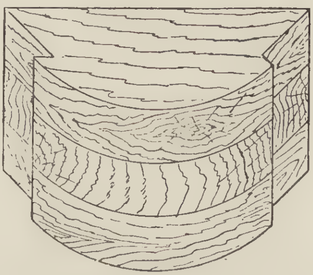


Fig. 116.—Three-piece Block for Bull-nose Step.

draw a full-size plan, of which Fig. 114 is a reduction, of both the step and newel, before commencing actual work on the

material; and Fig. 115 shows a section of this completed step. This done, the next task will be to get out the block marked B in Fig. 114, and shown apart at Fig. 116; this must be thoroughly dry and free from sap and knots. If a piece of stuff the correct size can be found, it will be best to use it; otherwise the block must be glued up in three pieces, as shown at Fig. 116, the grain of each being slightly crossed. When quite dry, it must be worked, or cut by band-saw, to the required

Fig. 117.—Riser marked for Cutting and Bending.

shape. Care must be taken not to have any lumps on the circular part of it, or there will be a cripple in the veneer when it is bent round the block. The riser must be dry and free from sap, shakes, knots, and coarse grain. Carefully smooth up the face of the riser, lay it face down on the bench, and mark it for the reception of the block. Mark the bevel end on the riser, roll the block steadily over the back of the riser, and mark where the wedges are required.

Fig. 118.—Block in position for Bending Riser.

Fig. 117 shows how the riser is reduced to a veneer for bending round the block, as illustrated by Fig. 118. Plenty of hot water, also a piece of flannel well soaked in it and laid on the face, will cause the veneer to bend round quite easily. The riser should be counter-wedged at the springing, and then screwed to the block from the back side, as shown at Fig. 119, allowing about ½ in. for the wedging, marked W, Figs. 114 and 119.

It will often be found an improvement to place the wedges

about 2 in. from the springing on the straight part of the riser, as there is a tendency to get a cripple on the straight face of the riser just where the springing starts.

To cut the veneer as shown at Fig. 117 gauge a bare $\frac{1}{8}$ in.

Fig. 119.—Bent Riser fixed to Block.

from the face and chop out from the back, first making a number of saw-kerfs as marked in Fig. 117. Be careful not to let the saw-cuts go below the gauge line.

It is advisable to bend the veneer riser without having

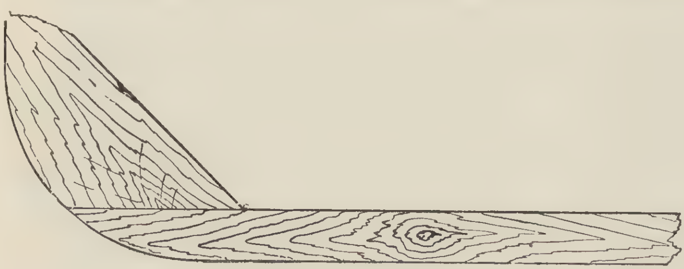


Fig. 120.—Scotia Cover.

recourse to steaming it in hot water, if the riser is deal, as this can easily be done without any fear of breaking it.

When the riser is not pliable, however, steam it in hot water for five minutes, place face down on the bench, and fix the block in position with two screws (one is shown in Fig. 118). Bend it gently but firmly round, wedge it with two folding wedges w (Fig. 119), screw it properly, and lay it aside to

dry. While it is drying, get out the scotia cover and tread. The scotia can be got out of one width of board, or two pieces may be glued together to make the width. The object in getting out the scotia in two pieces is to economise the stuff. Work the scotia after it is nailed on the riser. The scotia cover shown in Fig. 120 is a strip of stuff about 2 in. wide and of the required length, with a piece glued on the end to make the required width. Lastly, fix on the tread, which can be rounded before it is put on. The scotia should be screwed first to the riser and afterwards to the tread, and nails should not be used.

In the bull-nose step illustrated by Fig. 121 it is necessary to

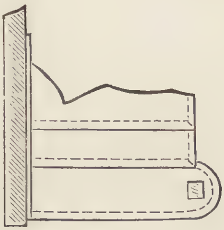


Fig. 121.

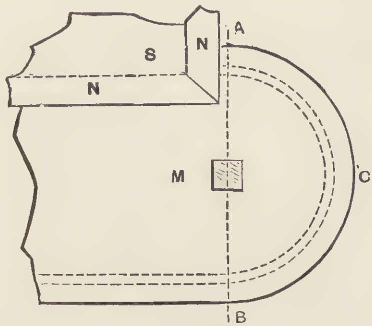


Fig. 122.

Fig. 121.—Plan of Bull-nose Step. Fig. 122.—Enlarged View of End of Bull-nose Step.

set out the step to full size on a board to work from. First draw a corner edge of the next step above, as S (Fig. 122). Now, with a pair of compasses set to the radius of half the breadth of a tread, draw the semi-circle A C B. The semicircle must coincide at A with the face of the riser on the step above. The nosing-line must be struck outside this mark, at an increased radius equal to the projection over the riser: this instruction must be carefully observed, for, if the line be struck as shown at the dotted lines, the nosing, it is obvious, would fall short. As the end of the step must be solid, several pieces of deal must be glued together to make up the required thickness. As an example, suppose the steps to be 8 in. high. Now deduct from this the thickness of tread ($1\frac{1}{8}$ in.) and cove ($\frac{7}{8}$ in.), which will leave 6 in.

to block up. As it is necessary to glue up the block in several thicknesses, with the grain crossing, three 2-in. boards may be taken for the purpose.

For the blocks, select three pieces of stuff as dry and free from knots as possible, otherwise it will shrink and cause the veneer to bulge out. The pieces should now be cut roughly to the shape of B (Fig. 124), and glued up to make one block with the grain crossing, as shown at Fig. 123, *a*, *b*, and *c* being the parts of which the block is built up, *d* the cove, *e* the tread, and *f* the veneer; but care must be taken that it does not cross at right angles, or the block will shrink unequally. Put the block under pressure and allow the glue to harden.

As the veneer is really a portion of the riser, reduced to $\frac{3}{16}$ in.

Fig. 123.

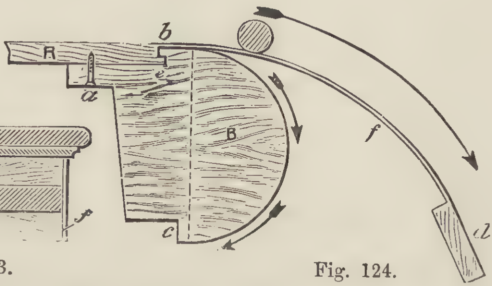


Fig. 124.

Fig. 123.—Section through Step. Fig. 124.—Bending Riser round Block.

in thickness to enable it to bend round the block, it will be necessary to make the block $\frac{3}{16}$ in. smaller than the finished size of the step, so that when the veneer is on it may be of exactly the size required. In Fig. 124 the riser R is of its full thickness ($\frac{7}{8}$ in.) along the front of the step. But on arriving at the rounded end, where the block B is, the riser has to be reduced in thickness in order to allow of bending it round the block. At the termination of the thinned part between *b* and *d*, Fig. 124, called the veneer, there is a short piece *d* of full thickness ($\frac{7}{8}$ in.). To bring the outer surfaces of R, *b*, *d*, and the veneer between them to one smooth curve, as shown at Fig. 124, notches must be cut in the block at *c* and *e* (Fig. 124). The veneer is $\frac{3}{16}$ in. thick, and so these notches must be $\frac{7}{8}$ in. less $\frac{3}{16}$ in. deep—that is, they must be $\frac{11}{16}$ in. deep. It is known that the riser must be 6 in.

high, and its total length is ascertained by measuring round the block with a piece of string, and allowing the length of the other part of the riser beyond this. A piece of stuff sufficiently long to allow for the veneer and beyond must then be planed up. This having been done, set off about 4 in. from the end, as from *e* to *a* (Fig. 125), and measure with a string the necessary length for the veneer, which should be marked as from *a* to *c*. Now set a gauge to $\frac{3}{16}$ in., the desired thickness of the veneer, and run it along both face-edges of Fig. 125. Make two saw-cuts, about 4 in. apart, through *a* and *b* down to the gauge mark. Carefully clear out the wood between the cuts with chisel and rebate plane. Then fix the riser in the bench vice, and with a fine saw cut down the inside of gauge, line from *b* to *c*. In cutting, be careful to cut accurately to the line, as should the saw run outside the line *b c* it is very probable that in bending round the block the veneer will split. Finally, the piece *f* (Fig. 125) may be removed by running in a tenon-saw at the point *c*. Cut a $\frac{3}{8}$-in. tongue at the end *c*, to help to keep the riser close to the block.

Fig. 125.—Riser ready for Cutting Veneer.

When it is found advisable to steam the veneer, it should be held over a kettle of boiling water until quite limp and pliable. The tongue C must now be inserted in its position in the block (see *e*, Fig. 124), and two screws put in at *a*. With a few shavings dipped into the hot water, gently press the veneer down to the block in the direction of the arrows. A perfectly smooth wooden roller, about 12 in. long, may with advantage be employed in this process, as it tends to keep the grain down should it show any inclination to rise in splinters, as will occasionally happen if the stuff is not very mild and pliable.

When the veneer has been wound round the half-circular end of the block, it will be necessary to stretch it tightly in its place. This is done by cutting off the half-circular end from the rest of the block just through along the line A B (Fig. 122). Before sawing it through, however, a square hole marked M must be made through the block at the centre of the line A B. This square hole must be of the same section from side to side, and must be chiselled smooth along all four sides. The saw-cut

made through A B, by separating the end from the rest of the block, allows the veneer to be tightened by wedging.

Before bending the veneer, a pair of folding wedges (Fig. 126),

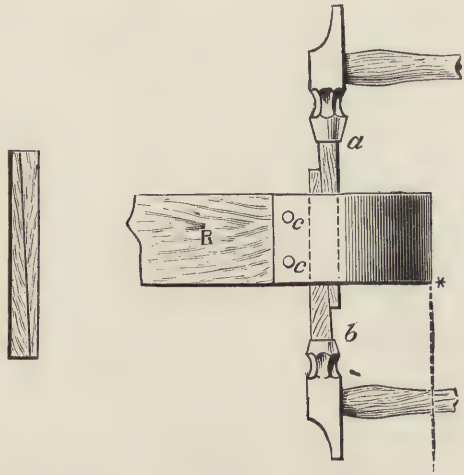


Fig. 126.—Folding Wedges for Tightening Veneer.

about 8 in. long, should be made. The veneer having been successfully bent round the block, the wedges should be inserted into the mortised hole, one from each side, and gently driven

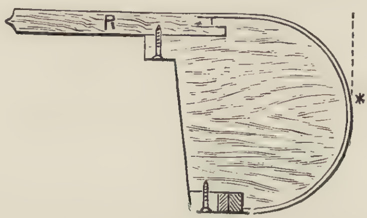


Fig. 127.—Riser bent around Block.

simultaneously from top and bottom, as shown at *a b* (Fig. 126). Should the riser be inclined to draw away from the block during this process, a small cramp may be used to keep it down, and two long screws inserted in the holes *c c* provided for the purpose.

As the veneer will now bend round the block satisfactorily, it may be removed, and both block and veneer well glued, with the glue about as thick as cream and quite hot. The veneer should be again bent down, using the roller to press out the glue. As in all joints, the more glue pressed out the better it will be. The wedges should be now driven tightly home, care being taken to drive them equally; as, should this not be done, the veneer may be drawn quite close on one side and perhaps $\frac{1}{8}$ in. away from the other, which is bad workmanship.

The block, after being allowed to get thoroughly dry, should be cleaned off, when it will appear as shown by Fig. 127. As the

Fig. 128.—Tenon on Newel.

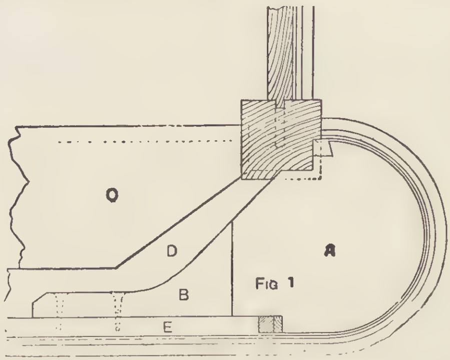


Fig. 129.—Connecting Bull-nose Step and Newel.

cove or moulding under the nosings shows $\frac{7}{8}$ in. by $\frac{1}{2}$ in., a piece of $\frac{7}{8}$-in. stuff should be worked out, $\frac{1}{2}$ in. larger than the finished block, and cut down to about 2 in. wide beyond the block and over the riser R. Work the cove on the edge, and nail it down to the block. The tread should now be worked along the front edge and round the block to the springing-line. The tread may be fastened down by means of a few fine screws passed through the cove underneath; they will not be seen if put in carefully. The step may now be notched out for the string, on which a piece has been left beyond the riser for the purpose of fixing to the step. This is fixed by driving in a few screws from the back and under-edge. A tenon *a* (Fig. 128, see also Fig. 143), about 2 in. square, must be cut on the newel *b*, long enough to pass through the step. The folding wedges having been removed

from the mortised hole, M, Fig. 122, the newel tenon may be inserted. This tenon is sometimes passed down through the floor, and fixed by means of wedges inserted from under the joist. A long bolt is used occasionally for the same purpose.

Figs. 129, 130, and 131 show a good method of connecting a bull-nose step and newel. Fig. 129 is a plan (looking from

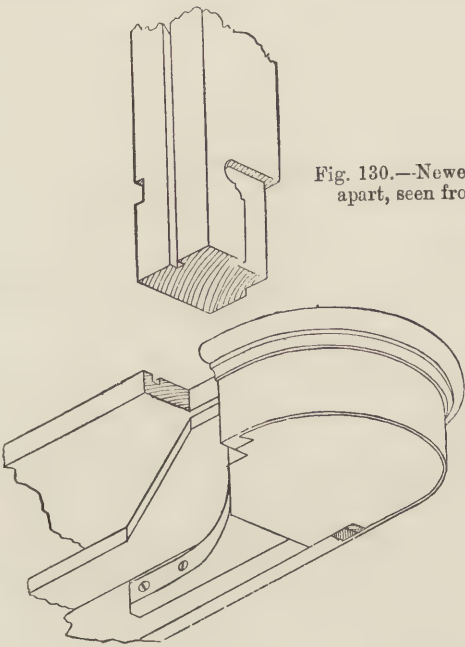


Fig. 130.—Newel and Step apart, seen from below.

below); A is the block, made of three thicknesses, and B is the rib forming the middle piece of the block; C is the step, D the solid scotia, and E the riser. Figs. 130 and 131 are isometric views (looking from the under-side) when the newel and step are apart and together respectively.

The height of the rail in Fig. 110 has been slightly increased at the bottom, to obtain the easement into the newel. This arrangement has been explained previously, and the only difference in this example is that the rail passes directly into the newel

instead of finishing with a cap, as in a former example. The newel on the landing L, Fig. 110, is often made long enough to pass

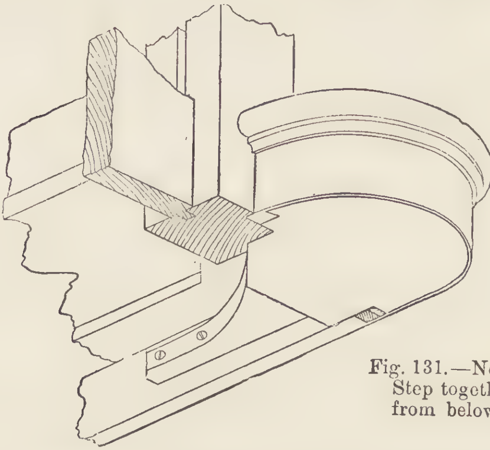


Fig. 131.—Newel and Step together, seen from below.

down to the floor below, forming a support for the stairs and a jamb on which to hang the door in the spandril. This requires

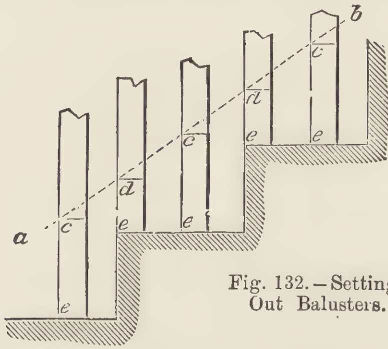


Fig. 132.—Setting Out Balusters.

a large piece of stuff, and the carriage-pieces, with spandril combined, afford ample support for the stairs.

The balusters should always be set out by the joiner, so that

they may have squares in proper proportion. The turned parts should all be of one length, and the squares should range in a line parallel with the nosings. To obtain this, draw several steps and risers to full size, as at Fig. 132, and draw the balusters each in its right position, as before described. Now, on two of the balusters that come immediately above the risers, mark the length of the squares, as *e d* (Fig. 132). By drawing the line *a b* through the points *d d*, the length *e c* of the squares for the intermediate balusters will be obtained. If the squares were all of one length, the turned part would differ in length and look unsightly. The squares on the top of the balusters will, of

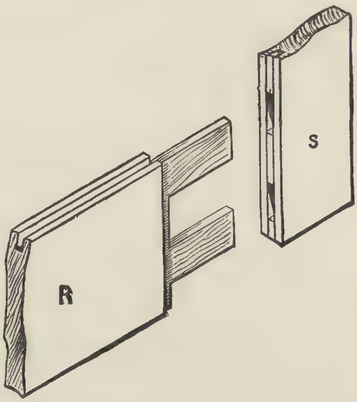


Fig. 133.—Tenoning Rails into Stile.

course, all be of one length (about 4 in.), as they follow the even line of the handrail.

The triangular piece of framing under the staircase, Fig. 110, is known as a spandril, and is made in various ways. The stuff used is $1\frac{1}{4}$ in. in thickness. The bottom rail B is 9 in. wide, as is also the middle rail M. The top rail T, stile S, and mullions or muntins *m*, are each $4\frac{1}{2}$ in. wide (see Fig. 110). The spandril is divided into a number of equal parts for the panels, according to the width of stuff from which the panels are to be made.

The framing is usually joined together with mortises and tenons, as in making a door, Fig. 133. This will do very well at *e* and *d* (Fig. 110), as M and B are at right angles to S; but to mortise

through the rails and stile at *a*, *b*, and *c* would be impracticable. Therefore, as the back of the spandril is scarcely ever seen, it is

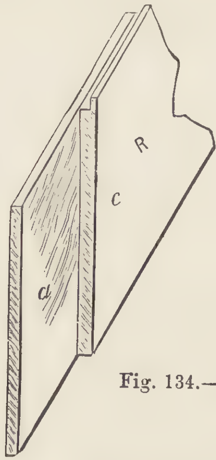


Fig. 134.—Halving Rail.

the better plan to halve the parts together at these points. This method, Fig. 134, is undoubtedly the stronge and quicker ; and if

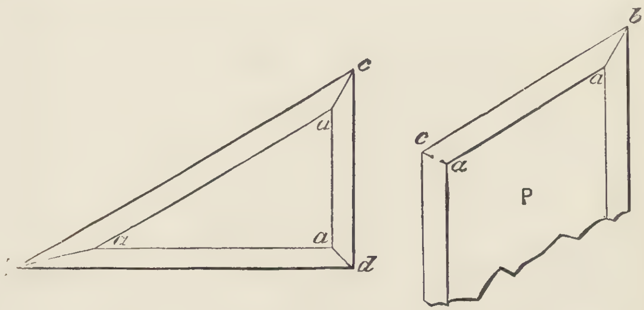


Fig. 135.—Cutting Mouldings on Various Angles.

care is taken in halving out the proper members, the difference, when all is screwed and glued together, is not perceptible. At D (Fig. 110) is shown a cupboard front, provided for hanging a door,

the middle rail of which is kept at a height of 3 ft. 2 in., the same as M, the middle rail of the spandril.

Fig. 133 shows the manner in which the middle and bottom rails M and B are framed into the stile S. In Fig. 133, R is the rail and S the stile. Fig. 134 illustrates the method by which the middle and bottom rails are halved to the top slanting rails.

Mouldings of various kinds are placed in the panels. In the present instance a small moulding very commonly employed is shown at Fig. 136. The mouldings on several of the panels may

Fig. 136.—Panel Moulding and Proper Way to Nail it.

be cut by means of the ordinary mitre block of 45°; on those, however, that meet the top rail, panels *p p*, Fig. 110, for instance, a different mitre is required. To obtain this mitre, draw a line indicating the width of the moulding all round the panels, as shown by Fig. 135, and from the points of intersection, as *a*, *a*, *a*, to the angles of framing, *b*, *c*, and *d*, draw other lines, *a b*, *a c*, and *a d*, which represent the mitres required. If the mitres are not cut correctly the different members of the moulding will not join together. When nailing in the mouldings great care should be

Fig. 137.—Incorrect Way of Nailing Moulding in Panels.

taken that the brads pass into the framing at the back, as, should they pass into the panels, the effect, when the panel shrinks, will be that the moulding will move away from the frame. In Fig. 136, *a* shows the proper position of the brad; at *b*, Fig. 137, is shown the brad passed into the panel; and *c* shows the result of such nailing after the panel has shrunk.

A staircase differing as regards some of the smaller details from those already treated on in this chapter will now be considered, attention being given chiefly to the lower portion. The staircase has a cut and bracketed string and two bull-nose steps.

The leading dimensions are as follows: Going, 12-in. rise, $5\frac{1}{2}$-in. treads, $1\frac{3}{8}$ in. finished; cut string, $2\frac{1}{4}$ in. thick; newel in largest part (at base), 7 in. square; balusters, square parts, 2 in. by 2 in.; handrail, $3\frac{1}{2}$ in. by $4\frac{1}{2}$ in.

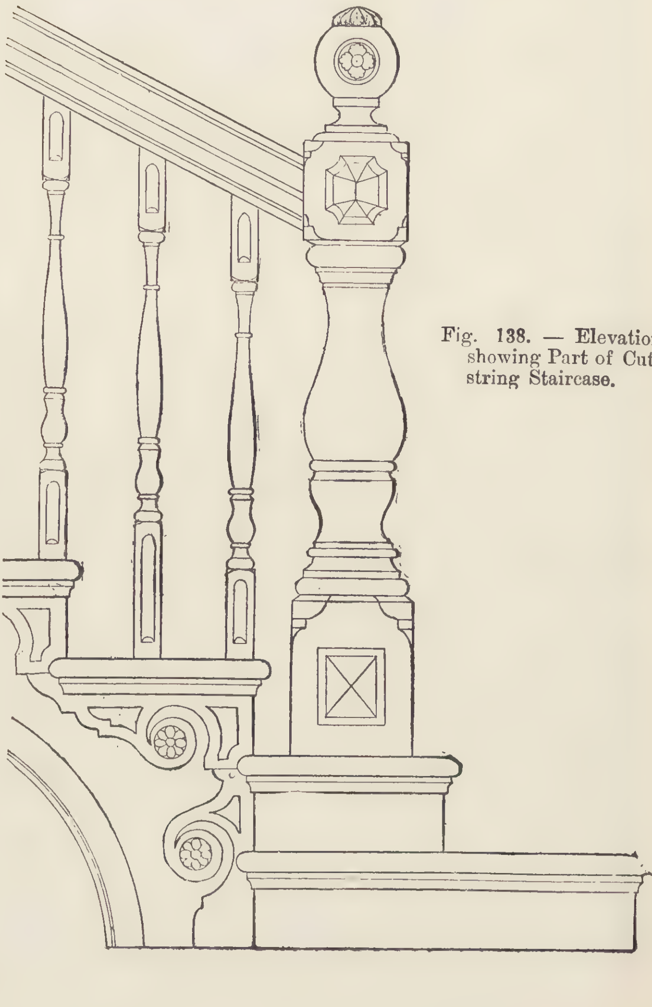


Fig. 138. — Elevation showing Part of Cut-string Staircase.

Fig. 138 shows the elevation of the string, bull-nose steps, newel balusters, and handrail; Fig. 139 is the plan of the risers of the two bull-nose steps; the treads and scotias are assumed to be removed, but in order that the details of construction may be shown clearly the nosings are indicated by dotted lines.

In setting out these steps, the springing line shown at A A (Fig. 139) should always be an inch or so outside the face of the string. The blocks are formed each of three thicknesses, jointed and glued together. An important point to remember when

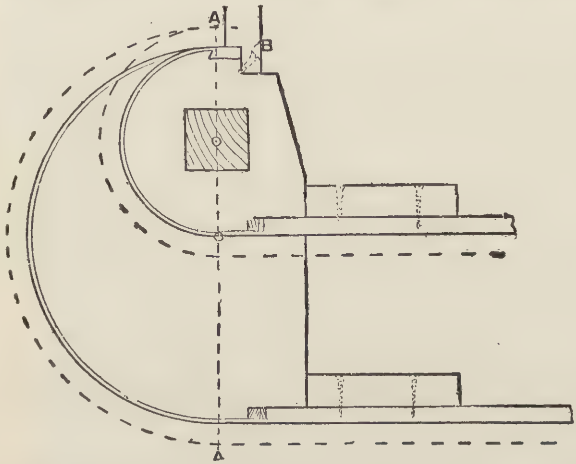


Fig. 139.—Plan of Risers and Blocks of Bull-nose Steps.

preparing the pieces for these blocks is to have the grain, not at right angles, but at an angle of about 45°. The middle block has a projecting rib, which is screwed to the riser after the veneer is stretched on and keyed, as has been already described in this chapter.

Fig. 140 is a conventional view of the steps looking from beneath. It shows the underside of the bull-nose step, a portion of the string, and the lower part of the ornamented newel.

A good method of connecting the string and bullnose steps, and securing them by means of screws, is shown at B (Fig. 139); the exact form for cutting them to fit together is shown by the views at C (Fig. 141) and D (Fig. 142), Fig. 141 being an isometric view looking from the underside, showing the construction of the

bull-nose steps, and Fig. 142 the cut string prepared for receiving

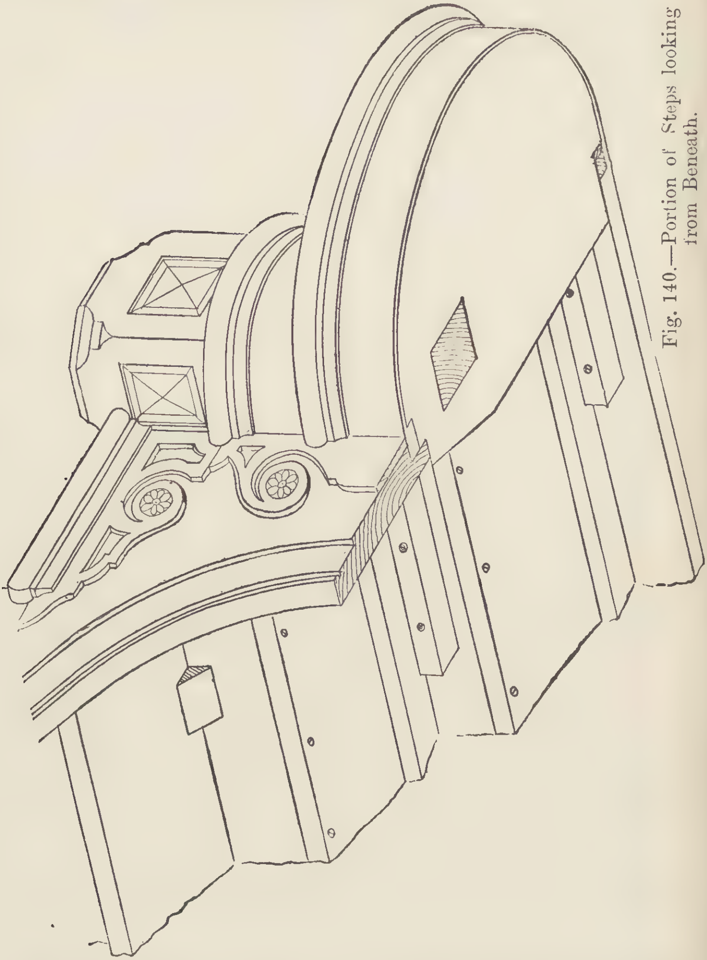


Fig. 140.—Portion of Steps looking from Beneath.

the steps shown at Fig. 140 Fig. 142 shows at F the riser rebated and mitred.

In the stairs shown by Fig. 138, the centre of the newel stands on the centre of the springing of the top bull-nose step. To make the newel firm, it is a good plan to make a square mortise hole right through both of the blocks, as illustrated. To ensure the newel standing plumb when fixed, the hole must be made quite square. The newel should be shouldered and tenoned as shown at Fig. 143, the tenon being glued and wedged into the mortise of the steps. It is desirable to further

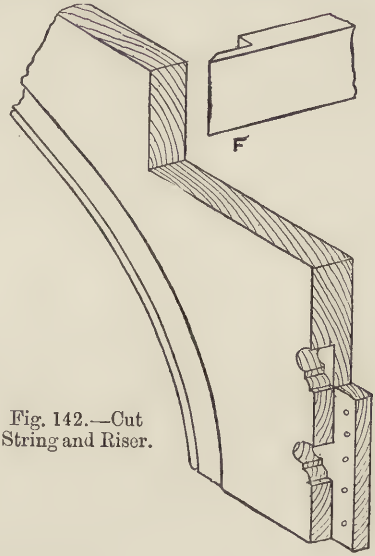


Fig. 142.—Cut String and Riser.

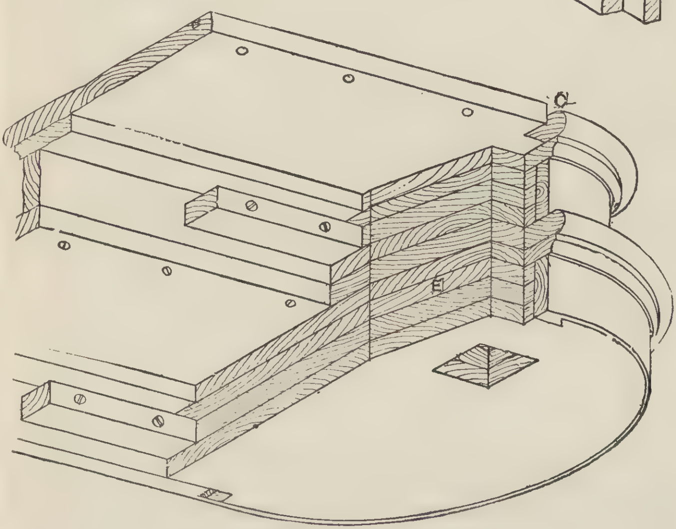


Fig. 141.—View of Bull-nose Step.

secure the newel by means of three or four stout screws from the back of the block at E (Fig. 141). Of course the wedging should be carefully done, so as neither to split the blocks nor start the veneer, great care being also taken to keep the newel square.

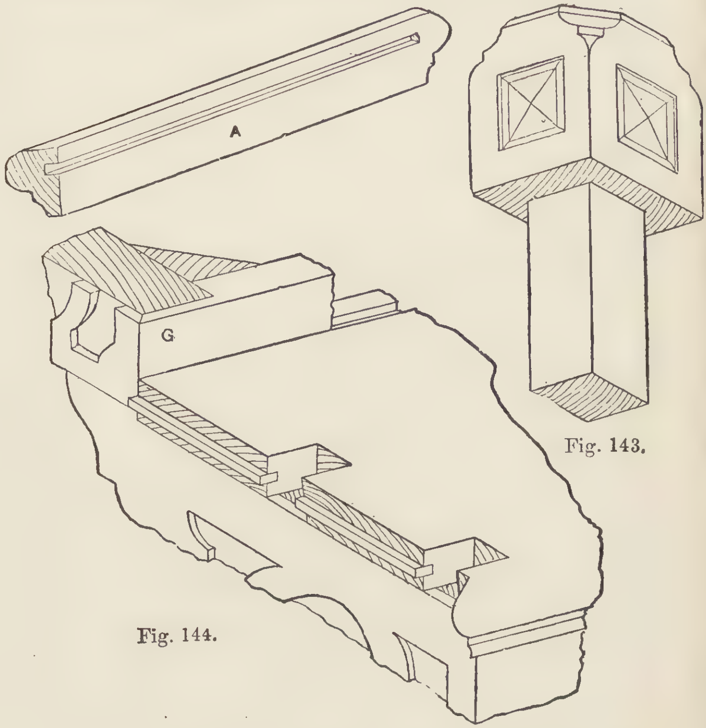


Fig. 144.

Fig. 143.

Fig. 143.—Lower Part of Newel. Fig. 144.—Details of Sunk Cut String and Returned Nosing.

Details of the sunk cut string, rebated and mitred risers, shown at F, Fig. 142, are illustrated at G, Fig. 144; mitred returned nosings, which are secured to the end of the step by tongues inserted in ploughed grooves, are shown at A, Fig. 144.

CHAPTER XI.

GEOMETRICAL STAIRCASES.

A GEOMETRICAL staircase is continuous, in the sense of having no intermediate support across the opening, as a joist at a landing, and although it is usually in one uniform series of steps, a break in continuity of the flight is not sufficient to prevent its being classed as a geometrical staircase.

Geometrical staircasing is regarded as representing the highest form of joinery; and the reader is advised that without a sound knowledge of geometry this branch of the craft cannot be effectually studied, as it leads up to the art of handrailing, which requires a specia system of lines, and the application of strict geometrical principles. Therefore a knowledge of practical plane and solid geometry is essential to thoroughly proficient workmanship; and such knowledge, where not already possessed, should be acquired from a good manual on the subject. Of course, it is not meant to be inferred that without a knowledge of practical geometry a flight of geometrical stairs cannot be constructed, for anyone possessed of ordinary intelligence can make such a flight by carefully following these directions; but by the aid of geometrical lines the work becomes both easier and more interesting, for then the why and wherefore of every detail can be plainly seen, and the working will not be by rule of thumb. Moreover, sound scientific knowledge must of necessity render the craftsman quicker at his work—a very important consideration in these days of keen competition.

As has been indicated the handrail of a geometrical staircase extends from floor to floor without a break in continuity. When ascending or descending a geometrical stair, the hand can be run smoothly along the top surface of the rail, from storey to storey, without encountering any obstruction. There are many kinds of geometrical staircases, their form depending, as in ordinary stairs, on the height and going. It is, of course, unnecessary to give examples of forms of stairs which differ but little, in main principles, from others already shown in former chapters. As the arrangement of the risers in the well governs, to a certain

extent, the appearance of the handrail, great care should be taken in this respect.

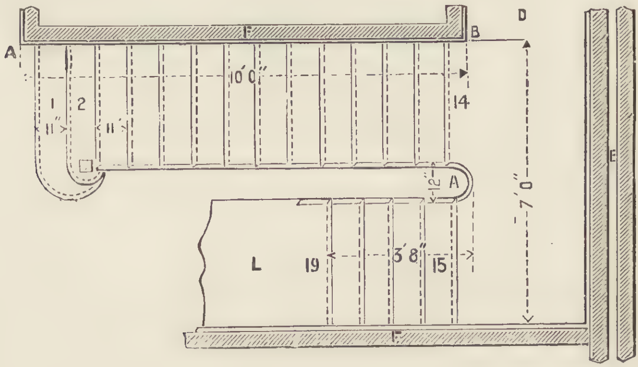


Fig. 145.—Plan of Geometrical Staircase.

In preparing the working drawings, divide the height and going as before described. The width of the stairway in Fig. 145

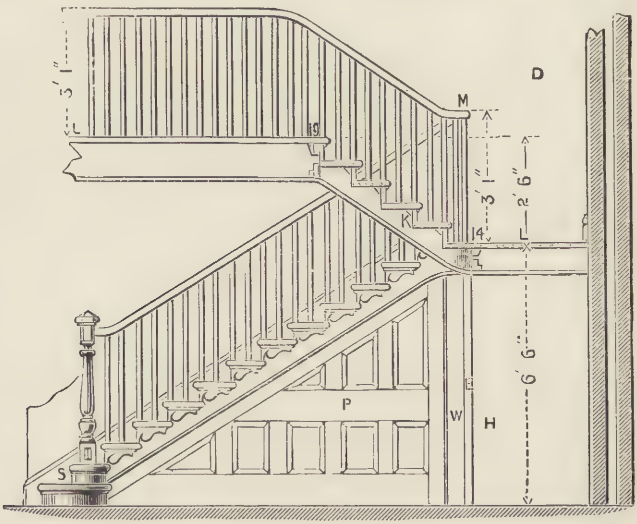


Fig. 146.—Elevation of Geometrical Staircase.

is 7 ft. and the width of each flight is 3 ft. from wall to string. Thus there is 1 ft. for the well or space A between the two flights. Set the compasses to the radius of 6 in., and describe the semicircle at A, joining the top and bottom strings. Set out the elevation (Fig. 146) as shown. The two bottom steps, shown in plan and elevation and numbered 1 and 2 in the former, give a good appearance to the stairs, and are worked and veneered as described in Chapter X. Fig. 147 represents an enlarged section, showing at S the string; T, the tenon on the newel, which passes through both steps; N, the newel; *c*, coves; *t*, treads; *b*, blocks; and *v*, veneer.

It will be convenient here to describe a method of preparing

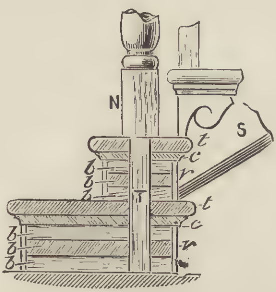


Fig. 147.—Section of Commode Steps.

blocks for veneering curved risers for steps, or for skirtings, which has many advantages over the usual plan of cutting them out of the solid wood. The drawings here given are perhaps sufficiently explanatory of the principle on which the blocks are constructed and of the method of setting out. To make only one block by this improved method would perhaps take as long as if the old plan were adopted; the block would, however, be constructed on more scientific principles, and if a number of blocks were made at one time there would be a considerable saving of time and material. In addition to this, the block is more easily and more firmly fastened down during the actual veneering, which is a considerable advantage, because in blocks made by the old method the small bird's-mouth rebates at the ends make it rather difficult to place the screws satisfactorily. The block is also more easily manipulated in the final process of

veneering and keying, as the hand-screws can readily be put into use, on account of the projecting wings at the ends. The method is easily applied to circular, elliptical, and other forms, thus superseding the laborious process of building up blocks by means of slabs. Figs. 148, 149, and 150 show, respectively, how a quarter, a half, or a three-quarter turn can be constructed—the letter A in each figure indicating the folding key-wedges—and are drawn to accommodate a circular curve of 5 in. radius; but both larger and smaller sweeps can be made without much increase or decrease of scantling. After setting out full size on a

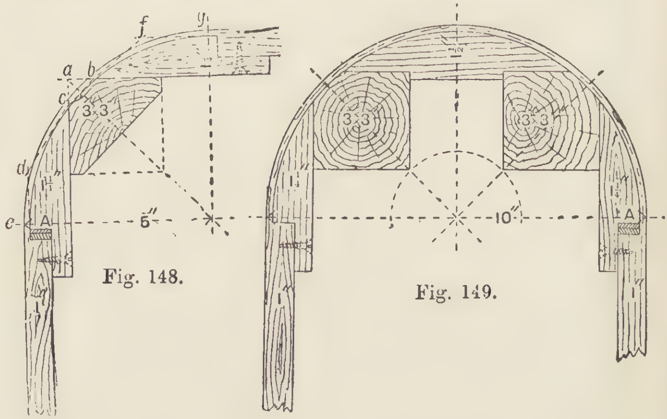


Fig. 148.—Quarter-turn Step. Fig. 149.—Half-turn Step.

board, and marking the tangent lines *d*, *c*, *b*, *f*, as in Fig. 148, face up and make square with each other two sides of a piece of 3-in. by 3-in. quartering, which should be as long as the total height of the blocks to be worked at one time; 9 ft. or 10 ft. is a reasonable length, and should not be exceeded. Mark lines $a\ a'$ and $b\ b'$ on the quartering, as shown by Fig. 152, to correspond with the distance $a\ b$, $a\ c$ in Fig. 148 at distances equal to the height of the risers required; then square over lines as 1, 2, 3, 4, Fig. 152. Next prepare the cheek-pieces, as shown in Fig. 152, facing up both sides and bringing them all to a uniform thickness; these should be just long enough to make one pair of cheeks. Set them out by marking a bevel line across the centre to correspond with

angles $e\ d\ c$ or $b\ f\ g$ (Fig. 148), and making the distances $e\ d$, $e'\ d'$ (Fig. 151) equal to $e\ d$ and $f\ g$ (Fig. 148). Square over the shoulders on opposite sides, cut the pieces, and fix them, in width as required according to the respective distances (which are not necessarily all alike) marked on the quartering. Fig. 152 shows the manner of fastening the several parts together by well gluing the cheeks to the quartering and securing them by nails or screws. Finally, the curve line is marked on each end of the full length, and the whole set worked straight through and round, from end

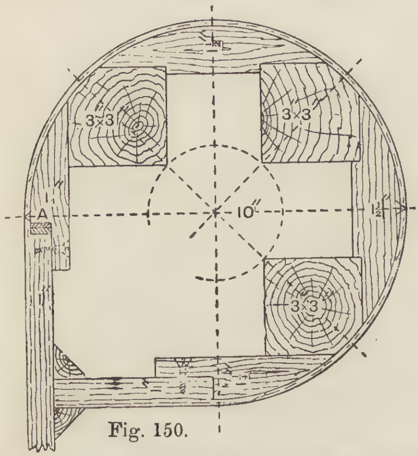


Fig. 150.

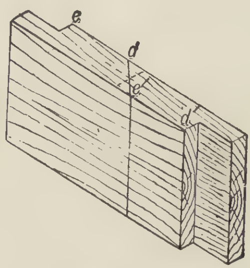


Fig. 151.

Fig. 150.—Three-quarter Turn Step. Fig. 151.—Setting out Cheek-pieces.

to end, at one operation. When finished, the blocks are separated by sawing through the quartering.

All stairs with a continued rail must have iron balusters fixed at intervals, to impart strength; about one of iron to every seven of wood will be sufficient. The iron balusters should be cast first, and the wooden ones turned to match them, as the metal shrinks in solidifying, and this would cause the iron ones to be smaller than the wooden ones if these were used to cast from; hence the wooden pattern baluster from which the iron ones are cast is made larger than the casting is required to be, so as to allow for the shrinkage of the metal on cooling and solidifying. At Fig. 153 is shown the part elevation of a baluster in position;

B is the baluster, F the flange (which should be made so that the bracket will afterwards cover it); N, the block, 3 in. by 3 in., to which the baluster is screwed; T T are treads. Fig. 154 is an end section, B being the baluster, F the flange screwed to the block N,

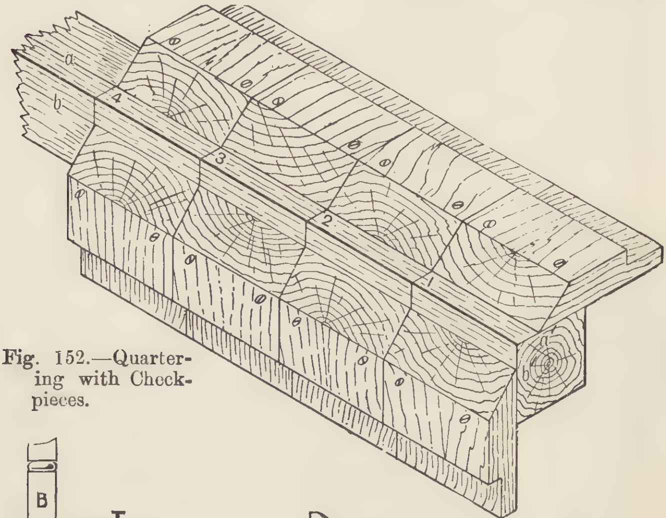


Fig. 152.—Quartering with Check-pieces.

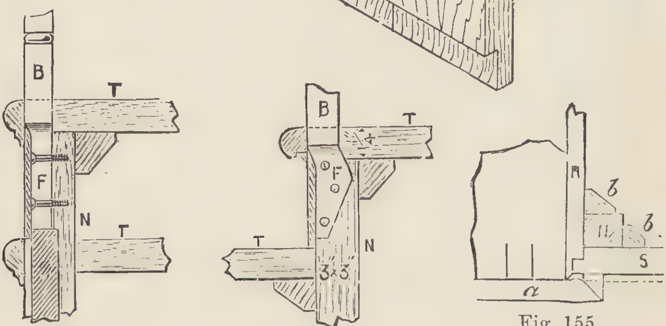


Fig. 153. **Fig. 154.** Fig. 155.

Fig. 153.—Part Elevation of Iron Baluster. Fig. 154.—End Section of Iron Baluster. Fig. 155.—Part of Stair Plan, showing Block for Iron Baluster.

and T T, treads. Fig. 155 shows a plan, N being the block, R the riser, *a* the returned nosing, S the string, and *b b* angle-blocks.

Fig. 156 is an elevation showing part of a carriage-piece. This piece is about 5 in. by 3 in. and is fixable in various ways, as

explained before (Chapter VI., pp. 71 and 72). In the present instance it is notched under each step, as at *a a*, and splayed against the trimmer T, a bolt B passing through both, keeping the stairs more firmly in position. C is the carriage-piece; I, iron baluster; N, block for the iron baluster passing below the string to receive the spandril; *b* is the bead on the under edge of the string. Fig. 157 is a section on A B (Fig. 149), showing C, carriage-piece; N, block; S, string; S P, spandril; T, tread.

The going being confined to such an extent as to allow of no easements at top or bottom of the string at A and B (Fig. 145), recourse must be had to another method. In Fig. 158 A is the true section of the moulding, which is worked separately,

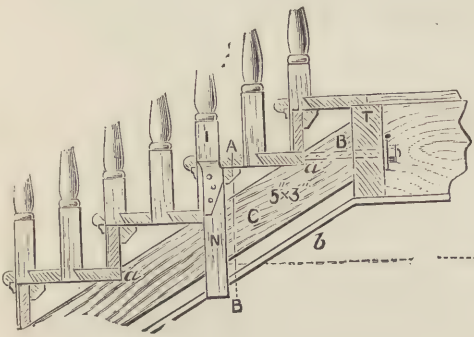


Fig. 156.

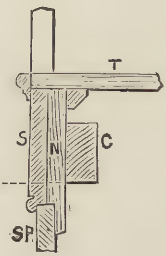


Fig. 157.

Fig. 156.—Part of Stair Elevation, showing Carriage-piece. Fig. 157. —Section on Line A B.

and fixed after the stairs are in position. Draw the line *a b* (making the same angle with *b* B as the string makes with the floor-line in Fig. 146), and mark the outline of the moulding at right angles to *a b* as shown at A. Mark any convenient number of points on the face of the moulding, and project them upwards to intersect with the line *a b* at 1, 2, 3, 4, 5, 6, 7. Next draw lines of indefinite length, parallel with *a b*, through points marked by the angles on the face of the moulding. To obtain the shape of the moulding for the skirting at the bottom of the stairs, draw a vertical line *b* B, and set off another line at right angles to it from *b*. On this line *b c*, mark off spaces corresponding in distance to 1, 2, 3, 4, 5, 6, 7, on A, and number them similarly,

as shown. Then drop lines from each of the points to intersect with those drawn from the groovings on A. Through the points of intersection thus obtained, draw the outline of the moulding by freehand, which results in the shape shown at B. For the top moulding proceed in precisely the same manner, and so obtain the section C.

Landings in a staircase of this class are often glued up in one piece, making, of course, a very superior job.

The spandril is framed as illustrated and described on pp. 107–109. In Fig. 146 W is a piece of stuff hollowed out to follow the

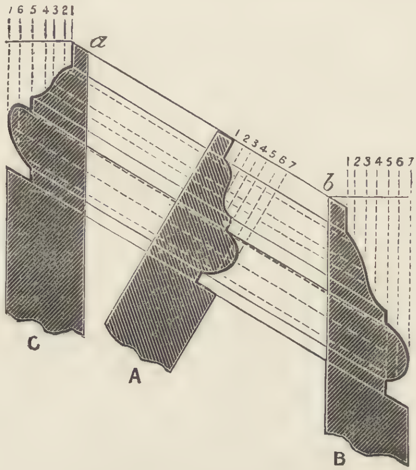


Fig. 158.—Method of Determining Lines of Moulding.

semicircular section of the well, and to finish on the edge E, at right angles to the stairs, a door being hinged to the edge there.

The well being 12 in. in diameter, set it out full size, as shown in Fig. 159. In all small wells the grain of the wood is allowed to run in a vertical direction; by this means no veneer is required. Four pieces of 2-in. stuff must be got out to the mould (which should be made from a piece of thin board) sufficiently long for the purpose, working the inside sweep with a large rounding plane. Fit the pieces carefully at the joints, and plough them for a $\frac{3}{8}$-in. tongue. This being done, place them over the drawing to see that the well is of the proper size, and glue up.

In Fig. 145, p. 116, it is shown that the baluster-string of the flight comprising Nos. 1 to 13 and the baluster-string of the flight comprising Nos. 15 to 18 are connected by an intervening part, A, known as the well. This well is, then, actually a part of the baluster-string, but it is curved to follow a semicircle instead of being straight like the rest. The baluster-string, otherwise known as the outer-string, is, as its name implies, at the baluster end of the treads as contrasted with the wall-string, which lies against the wall.

The well is shown enlarged in the plan (Fig. 159). It is built up of four pieces of wood B B B B, which are fashioned out of 2-in. boards. On one surface the board is planed to two flat faces,

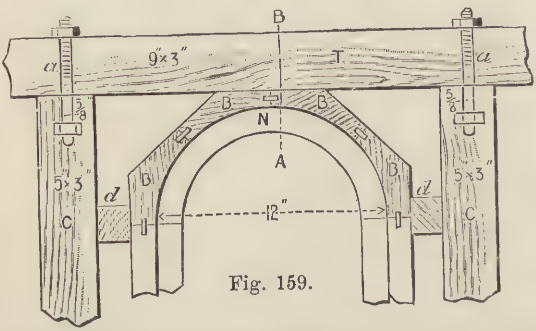


Fig. 159.

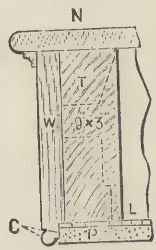


Fig. 160.

Figs. 159 and 160.—Plan and Section of Well of Geometrical Staircase.

which meet and make a ridge at the angle. On the other surface a rounded hollow is worked, curving to the eighth part of a circle in each of the four pieces ; these when put together, as in Fig. 159, therefore make up a half-circle The four pieces having been prepared to the section B B B B, shown in Fig. 159, the edges along which they join, and along which the two outside pieces are joined to the ends of the strings, are grooved to receive a tongue as indicated. A block of wood is then framed up to go inside the half-circular enclosure which B B B B form, and round this block they are placed with the tongues inserted and glued. Cramps are then used to put pressure on the whole structure till the glue hardens. In Fig. 159, C C are the carriage-pieces ; T is the trimmer on the landing ; B B B B are the four blocks forming the well ; *d d*, blocks to which the well is fixed ; N is the nosing ;

a a are bolts fixing the ends of the carriage-pieces to the trimmer. Fig. 160 is a section through the well; N is the tread; T, trimmer; P, plaster; L, laths; and W, the well itself. The rebate and bead at C are worked on the well to follow the rebate and bead on the string above and below.

In gluing-up the well, some means of keeping the joints firmly in position is necessary. At Fig. 161 is illustrated a dog or cramp, a most useful appliance that may be made at very small cost by any blacksmith. It is, essentially, a large iron staple, about $2\frac{1}{2}$ in. long on the top, the same from the top to the points, and $\frac{1}{4}$ in. in thickness. It should be made to taper as shown at C. To use the cramp, place together two parts that are to be joined, insert one point of the dog in each piece, and gently drive it in with a hammer, when, from the effects of the taper, the two parts will be brought tightly together. A shows the plan of joint and cramp, B the elevation.

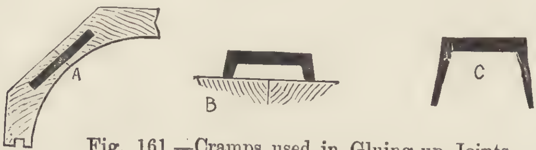


Fig. 161.—Cramps used in Gluing-up Joints.

Whilst the well is drying, the falling mould by which the well is to be marked out can be prepared. To do this, ascertain the distance round the inside of the well, which can be correctly obtained as follows:—Draw a line *b c* (Fig. 162), 12 in. long—that is, equal to the diameter of the semicircle that forms the plan of the well. From the point *e* as centre, midway between *b* and *c*, draw the semicircle *b f c*. Through *e* draw *f g* at right angles with *b c*. Through *f*, at right angles with *f g*, draw *a d*, which will of course be parallel with *b c*. From *c* as centre, with radius *c b*, draw the arc *b g*. From *b*, with radius *b c*, draw the arc *c g*. From *g*, the crossing-point of the two arcs, draw *g c*, and carry the line to *d*. Then draw *g b a* in a similar way. The length of the straight line *a d* may now be taken as equal to the length of the semicircular line *b f c*. In other words, the line *a d* is the development of the line *b f c*. A piece of string, just long enough to wrap from *b*, past *f* to *c*, round a semicircular moulding, would, on being pulled out straight, exactly measure the line *a d*.

A falling mould is wanted, to show the curve of the lower edge of the well. To make it, Fig. 163 must be drawn full size. Draw *a b* equal to the width of the upper surface of tread No. 12 of the stair illustrated in Fig. 145, p. 116. Draw *b c* equal to the front surface of the riser between No. 12 and No. 13. Draw *c d* equal to the upper surface of tread No. 13. Draw *d e*, the front face of the next riser. Draw *e f* equal to the line *a d* (Fig. 162). Draw *f g*, the next riser. Draw *g h* equal to tread No. 15. Draw *h i*, the next riser. Draw *i j* equal to tread No. 16. Draw *k l* and *m n* parallel with the nosing-line *a e* and *g i*. Then, between *l* and *m*, draw an easement or gentle curve running

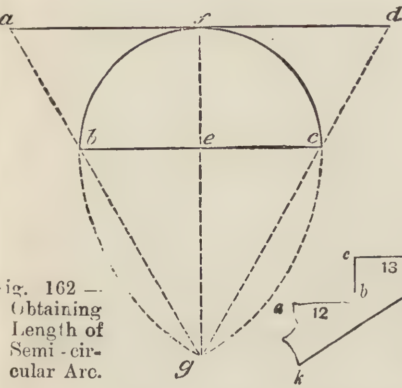


Fig. 162.—Obtaining Length of Semi-circular Arc.

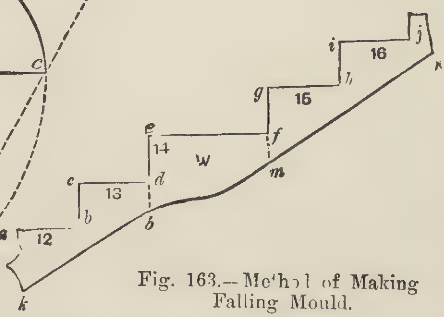


Fig. 163.—Method of Making Falling Mould.

smoothly into the straight lines *l k* and *m n*. The lines *k l* and *m n* show the under edge of the string, and mark the width of the string from *a c e* and *g i*.

The portion of Fig. 164 included within the points *e g l* and *m* must be copied on a piece of cardboard, which is then used as a template for transferring the curve to the well. Apply the line *e f* to the top edge of the well, and with a pencil trace the curve *l m* along the lower part of the well. A keyhole-saw or bow-saw must be used to cut round the line just marked; and in working the saw, care must be taken to keep the blade parallel with radii of the semicircle—that is to say, the line of teeth in moving backwards and forwards must always pass through the axis of the cylinder (or half-cylinder) on which the well is formed. The

student is advised to cut out paper or cardboard moulds for all examples to ensure exact results.

In all small wells the grain of the brackets may run in a vertical direction, the same as the well itself. Brackets may often be bent round after damping and warming at the fire, or steaming. Another method of preparing brackets for a well is to make a cylinder (see Fig. 164) and bend round it a thin veneer, on top of which stout canvas is then glued ; another veneer is then glued on top of the canvas to bring the bracket up to its required thickness, and then more canvas to bind all together.

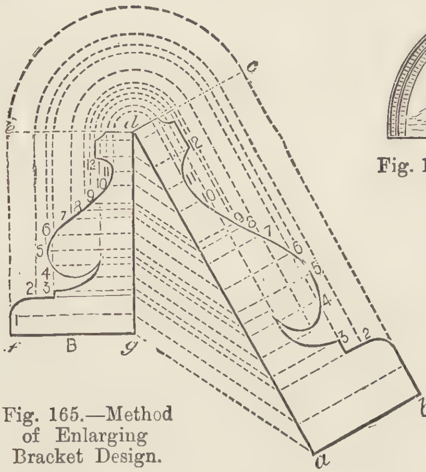


Fig. 165.—Method of Enlarging Bracket Design.

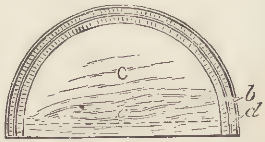


Fig. 164.—Cylinder for Shaping Brackets of Well.

The block of wood round which the well is built up is called a cylinder by staircase joiners, no matter what its actual shape may be.

As the ordinary bracket will not be long enough to pass round the well, an enlarged one of the same pattern as the others will be required. Draw, therefore, an ordinary bracket, as B (Fig. 165), and at a convenient angle (say 60°) draw a line *d a* equal in length to the perimeter of the well *a d* (Fig. 162). Now mark a sufficient number of points on the edge, as 1 to 12, and from these points project lines vertically to *d e*, and also horizontally to *d g*. Draw *g a*, and also all the other lines above parallel to it, as shown in Fig. 165. Draw *d c* at right angles to *a d*, and with *d* as centre, and the various points on *d e* as radii, construct a series of arcs terminating along *d c*. Continue these, *c b*, etc., parallel with *d a*. Draw the lines parallel with

a b from the points along *a d.* The points where these lines intersect will give points by which to draw (by freehand) the curve from *b* to *d*, showing the outline of the lengthened bracket.

In fixing the well, the stairs are first fixed in position, and the well is then blocked and wedged out from the carriage-pieces and well nailed.

Fig. 166 is the lower end of the newel, showing a sunk panel worked in the solid stuff to a depth of about $\frac{3}{4}$ in., as indicated in

Fig. 168.

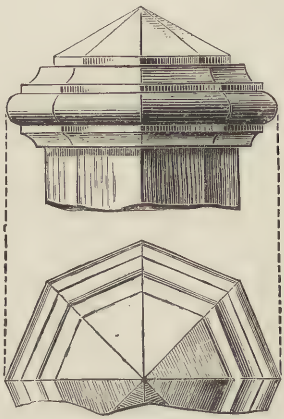


Fig. 166.

Fig. 167.

Fig. 166.—Newel with Panel sunk in. Fig. 167.—Cap for Newel.
Fig. 168.—Flanged End of Iron Baluster.

the section above. The moulding is occasionally also worked in the solid, but more often it is nailed in, as at *a*. Fig. 167 represents a form of cap that has a very handsome appearance if nicely worked, with all the angles sharp and clear. This is always worked out of the solid stuff. If this form of cap is adopted, the square on the newel immediately under it should also be worked to an octagonal shape; the two must agree. Fig. 168 shows the top end of an iron baluster, cast with a flange F, through which screws fix the balusters to the rail.

CHAPTER XII.

WINDING STAIRCASES.

Geometrical winding staircases, where a continued handrail is required, must be set out to give a good falling line. This point is often overlooked, the rail then having a crippled appearance. The term balanced or dancing steps is applied to a geometrical staircase, where the nosings of the winders are so placed as not to converge on the same point, but each directed to a different point, so that the inner edge of the tread is wider than it other-

Fig. 169.—Balanced or Dancing Steps.

wise would be, and the steps are thus intermediate in shape between flyers and winders. This allows of a better curve being given to the inclination of the handrail. In Fig. 169 the first four and the last three steps are ordinary parallel flyers, and the remainder are balanced or dance, as described. The winders should start before reaching the springing or centre line of the well, and may be equally divided both on the well and along an arc struck 15 in. from the centre of the well (10 to 15, Fig. 170). In other words, the uppermost of the winding treads (No. 15) should have part of its small end housed in the lower end of the straight string of the upper flight; the lowermost of the winding

treads (No. 10) should have part of its small end housed in the upper end of the straight string of the lower flight. The well-string only takes the housed ends of the intermediate treads (Nos. 11 to 14).

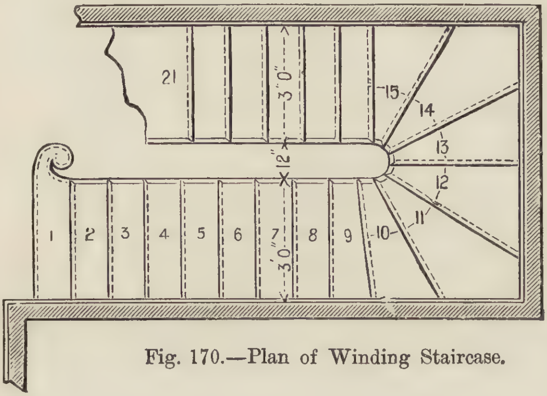


Fig. 170.—Plan of Winding Staircase.

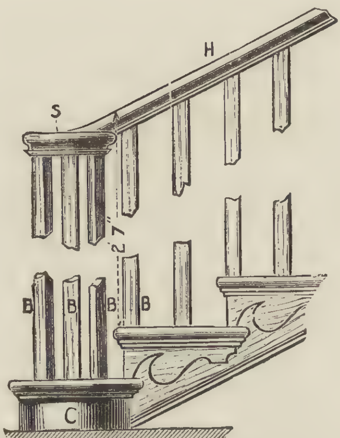


Fig. 171.—Part Elevation of Winding Staircase.

Fig. 170 is the plan of the staircase now to be considered, divided as shown, 10 to 15 inclusive being the winders. Winder

No. 15 is often kept the same distance from the centre of the well as No. 10. This is more especially the case when the rail is to be of one height both over the flyers and the winders.

Fig. 171 shows as much of the elevation as is necessary in the present instance. The scroll s over the bottom curtail step C is supported by balusters B B B, instead of by a newel as in former

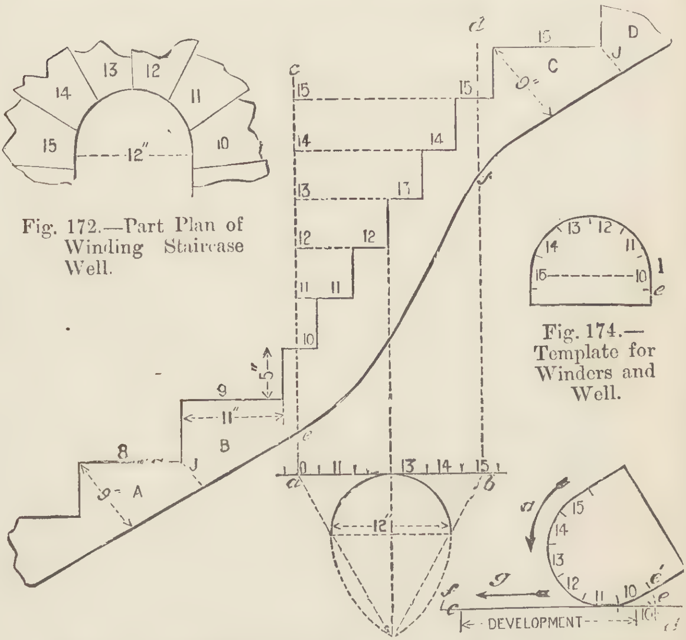


Fig. 172.—Part Plan of Winding Staircase Well.

Fig. 174.—Template for Winders and Well.

Fig. 173.—Development of Well String.

Fig. 175.—Application of Template.

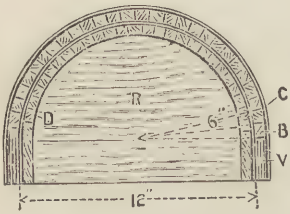
examples. It is unnecessary now to enter on the subject of the scroll, which properly comes under the heading of handrailing, and requires separate treatment. In Fig. 171, H is the handrail.

To obtain the development of the well, set out a plan of the well ends of the winders (Fig. 172), and obtain the stretch-out, or development of the well-string (Fig. 173). These operations have been fully described and illustrated in Fig. 163, p. 125. At *a*

and b (Fig. 173) erect perpendiculars, and mark off upon the line $a\ c$ winders Nos. 10 to 15.

From a thin piece of wood make a mould or template to the size of the well in plan, and mark on it the position of the extremity of each winder. Fig. 174 shows the template with the marks on it in their relative positions. Fig. 175 shows the application of the template in practice. Upon the development of the well $c\ d$, place the template, on its edge, with the point e' at e, and gradually roll it along from e to f, in the direction of the arrows a and g, marking along the development the position of each winder as it touches.

On the line $a\ b$, at 11, 12, 13, 14, and 15 (Fig. 173), is found



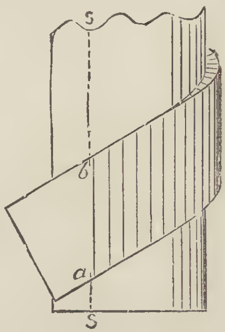


Fig. 176.—Plan of Cylinder for Building up Well. Fig. 177.—Part Elevation of Cylinder and Well.

the position of the ends of the winders around the well. From each of these points draw perpendiculars to intersect with horizontal lines representing the risers drawn from 11, 12, 13, 14, and 15 along $a\ c$. In this way, in Fig. 173, the development of the well-string, with the ends of the steps marked upon it, is obtained. Now draw two or more steps at both top and bottom, as A, B, and C, D; mark the depth of the string (9 in.) as shown, and from where the lines indicating the bottom of the string cross the lines $a\ c$ and $b\ d$, draw the easement shown by the thick line $e\ f$. The development (Fig. 173) must be transferred to thick paper and cut out for use as a template to mark the well-string for sawing.

A cylinder must be made, sufficiently high to build up the

well upon. It may be constructed by making about three half-round pieces of 1-in. wood R (Fig. 176) and connecting them with narrow strips glued close together around the curved edge. At Fig. 176, R shows the plan of a rib or semicircular piece of 1-in. wood; V, veneer; B, well-blocks; and C, canvas. These strips should be made to radiate from the centre as seen in the dotted lines at Fig. 176. They may be nailed upon the pieces R, placing one at each end of the semicircular edge and the others between. The edges must then be planed to a line struck with a 6-in. radius.

The first proceeding must be to prepare a veneer (as before described, Chapter XI.), and mark the springing-line *d b* (Fig. 173) upon it. Now steam the veneer as before, and mark the springing-line on the cylinder, as shown at S S (Fig. 177). Now place the springing-line *a b*, Fig. 177, on the veneer, opposite the line S S on the cylinder, and carefully bend the veneer round to its position, being careful that it does not draw away on either edge. Prepare a series of blocks or strips as done for the cylinder, carefully fit them on the veneer, and well glue them to it; a brad may be driven into each end where the blocks overhang the veneer, as such a course will not hurt the cylinder, and will hold the strips firm until the glue is hard. This being done, a piece of stout canvas or other suitable material should be glued over the strips to bind all of them together, making a sound job.

It will have been gathered from the foregoing paragraphs that the well is moulded or formed to shape by being bent around a frame of the correct shape and size previously prepared for it. The three or more half-circular pieces of 1-in. board (R, Fig. 176) are placed parallel with one another, but not close together; the slips D glued round the half-circular edges keep the three pieces R about a foot or more apart. The slips D are therefore about 3 ft. long and about 1 in. wide. The half-circle bounding R has a radius of $5\frac{1}{2}$ in. or $5\frac{1}{4}$ in., according as the slips D are $\frac{1}{2}$ in. or $\frac{3}{4}$ in. thick; then, when the slips D are glued round the pieces R, the half-circle formed by their outer edges can be reduced to exactly 6 in. radius by planing. When the veneer—which is a length of wood $\frac{3}{8}$ in. thick and 9 in. wide—has been bent round the cylinder in a spiral as shown in Fig. 177, cramps must be applied to hold it in position whilst the glued slips surrounding it are allowed time to harden; then the slips, canvas, and veneer forming the well will retain their shape after removal from the cylinder mould without material alteration taking place

The glue being thoroughly dry, the well-string may be taken from the cylinder, and the paper template (made from Fig 173, described on p. 131) applied to the inside of the curve, keeping the springing-lines in agreement with each other. Mark on the well the steps and under edge or easement, using the paper template made from Fig. 173 for the purpose. The notches and easement-lines should now be cut out with level landing—that is to say, be sure to keep the line of the saw-teeth radial from the axis of the cylinder whilst sawing the notches and easement-line.

The step shown in Fig. 170 is known as a curtail step, and is best set out after drawing the lines for the scroll (s, Fig. 171) on the handrail. Handrailing is quite distinct from staircasing, but

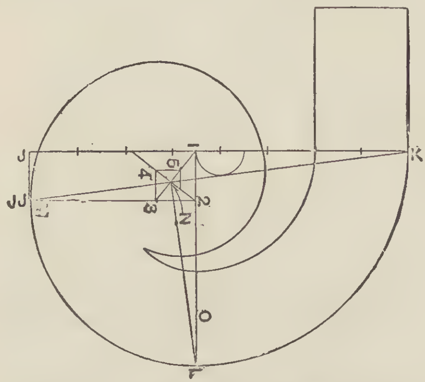


Fig. 178.—Setting Out Handrail Scroll.

it is convenient here to describe the method employed to obtain the lines for this scroll (see Fig. 178).

The size of the scroll being determined, divide the width into eight equal portions as shown on line J K; square down at J to J J; from J J draw a line to K; at the centre of the line J K describe a semicircle to touch the line J J K, and from the extremity of the semicircle nearest to J on line J K square a line across to L; then from point 1, with radius 1 K, strike the first quadrant round to L. From the point J J, and parallel with the line J K, produce a line cutting 1 L at 2; and from this point, with 2 L as radius, describe the second quadrant from L to M. Then from point L in the scroll produce a line square with, and

cutting, line J J K at N ; connect this point with point 1 on J K, and produce the line to intersect J J 2 at 3. From 2 through the same point of intersection produce a line upon which point 4 is found by squaring across from 3 ; point 5 is then found by squaring upwards from 4. All the points for centres from which to draw the outline of the scroll are now found, and for inner lines allow the width of the rail and proceed as before. The nosing and riser lines are then pencilled round, and the moulds taken from this ; the line of the nosing must follow the scroll exactly, less the difference of projection, but it is not usual

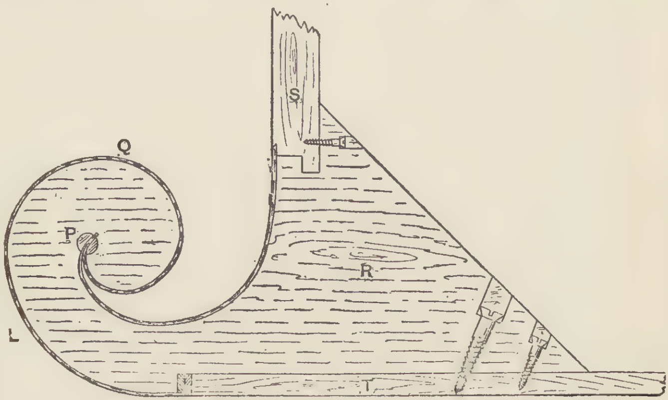


Fig. 179.—Block and Veneered Riser.

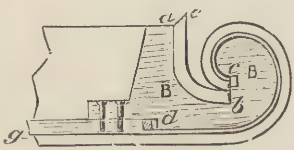
to adhere strictly to this for the riser, a little more stuff being left on the block to strengthen the neck.

Fig. 179 shows the method of getting out the block R for the veneered riser. It is not at all unusual for the veneer to be wedged into the block, but a large pin, say $\frac{3}{4}$ in. or 1 in. in diameter, as shown, is to be preferred. A saw-cut is run down the pin P as far as necessary, and the veneer Q is then put in, and screws are passed through both pin and veneer, which are then put into position and wedged. By adopting this method there is not so much strain put on the block as when double-wedging is adopted ; the pin should be 5 in. or 6 in. longer than actually required, the surplus being cut off after gluing in. If two veneers are used, the pin-hole must be arranged in the best

position to suit both ; but sometimes in painted work the string S is not veneered, the block being cut out and the string run forward as far as possible without interfering with the striking of the sweep.

There are different methods of preparing the riser T. In some places the veneer is cut down out of the solid ; in others, thin pine is used for this job, a piece of deal being glued on the back to wedge against ; the latter method is the quicker. It will be noticed that 1-in. easement is allowed at the curtail step ; this does away with the crippled appearance often noticed at point L when the first quarter of the scroll is struck off a straight riser-line. The step is then built up with a solid scotia, etc., similar to a bull-nose step, as described in Chapter XI.

At Fig. 180 is shown a plan of the step with the tread



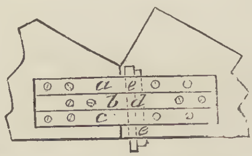


Fig. 180.—Plan of Curtail Step. Fig. 181.—Method of Cramping Joint.

removed. The block, which may be built up of three thicknesses, with the grain crossing, as in a bull-nose step, is cut to the shape shown at B B, a veneer being glued round from *c* to *d*, and wedged up, as done with the bull-nose step described in Chapter XI. The inner curve of the block *a b* is not usually veneered, as it is practically out of sight when the step is finished. The tread is cut to the shape of the block, and screwed from the under-side of the cove, which has previously been worked, and fixed by nailing to the block, as described in the preceding chapter. C (Fig. 171, p. 129) shows the elevation of the end of the step.

The well-string, having been prepared for the treads and risers in exactly the same way as the straight strings, may now be fitted in position. The well-string is usually joined to the straight string above and below it by a glued and wedge-cramped joint made 8 in. or 10 in. distant from the springing-line, as shown at J J (Fig. 173).

After fixing the well the joints may be drawn or cramped up

tight together by means of strips and wedges, as seen at Fig. 181. Three strips, about 12 in. by $1\frac{1}{2}$ in. by $1\frac{1}{4}$ in., are prepared, and placed together on edge, as *a b c*; at the centre *d* a wedge-shaped mortise is cut through *a b* and *c* to admit of the passage of one or a pair of wedges, as *e e*. At Fig. 182 is shown the method by which the string joint is drawn up. Across the joint the three strips are screwed, the middle strip to one piece and the outer strips to the other piece; and when the two string pieces A and B are brought together, the mortised hole through the middle strip is not quite opposite the holes through the outer strips, and when the wedges are driven through they force the three holes into line and thus form an exceedingly close joint. The wedge being driven in, other screws must be inserted in the free end of the strips, thus securing them in position. Of course it

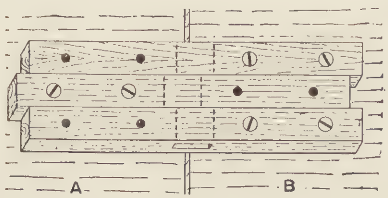


Fig. 182.

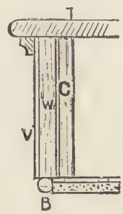


Fig. 183.

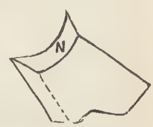


Fig. 184.

Fig. 182.—Cramping Joint by Inserting Wedges. Fig. 183.—Well Section showing Substitute for Return Bead. Fig. 184.—End of Winder near Well.

will be understood that the well is not to be fixed permanently until the stairs are in position.

As the return bead cannot be worked on the well in this instance, a piece of $\frac{5}{8}$-in. cane is nailed on as at B, Fig. 183. This figure is a section through the well, T being the tread, W well, V veneer, and C canvas. Fig. 184 is the end of one of the winders, the end being that one next the well; N is the return-nosing, mitred as shown.

As has been insisted on in the opening paragraphs of Chapter XI., the construction of a geometrical staircase necessitates a practical acquaintance with geometry; by the method about to be described, however, a geometrical winding staircase can be constructed by one whose acquaintance with geometry is not very extensive though some knowledge of staircasing, and

the ability to get out pitch-boards, set out wall-strings, easements, etc., are assumed. These matters have, of course, been already thoroughly treated.

Fig. 185 shows the ground plan of a staircase, with five winders in the well. The first winder is in front of the springing

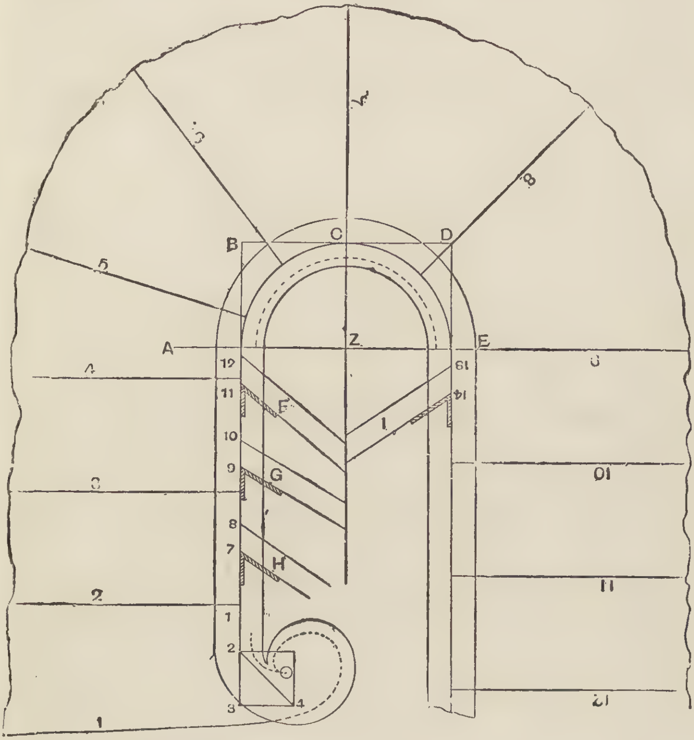


Fig. 185.—Plan of Winding Staircase.

line, it being arranged thus in order to give the wreath a better appearance, and to make the rake of the rail easier. F shows top bevel top wreath; G, bottom bevel top wreath; H, bevel for scroll shank; and I, bottom wreath bevel, both ends.

The striking of the handrail scroll, the getting out of the

block for the veneered riser, and the details of construction connected therewith, are matters that have been fully described on pp. 133–135, and illustrated by Figs. 178 and 179.

To bend the string round the well-hole, take a thin lath and bend it round the plan of string, as shown by the dotted line in Fig. 185, marking off the position of treads, and allowing for the joint with the straight parts to be clear of the vertical line of the risers when set up. With the lath as a base line, set out the treads and risers, and run the ordinary pitch on to the joint each way; this will give the length of string round the well-hole.

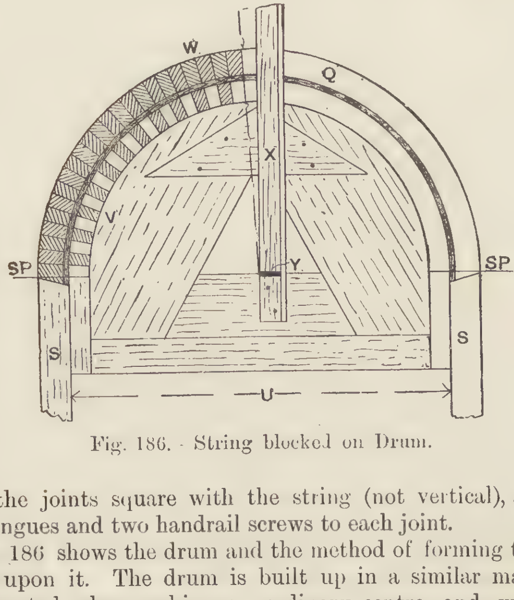


Fig. 186. - String blocked on Drum.

Make the joints square with the string (not vertical), and use cross-tongues and two handrail screws to each joint.

Fig. 186 shows the drum and the method of forming the bent strings upon it. The drum is built up in a similar manner to that adopted when making an ordinary centre, and, when the laggings are nailed on, it should be an exact fit to the sweep of strings on the plan, but extending a little beyond the springing line, and should be long enough to take the requisite number of risers. Particular care should be taken as to the width of the laggings, V, as the appearance of the finished string depends upon this.

To get the width of the laggings, also the blockings W for

strings, gauge a thin piece of stuff X as wide as the thickness of the strings, and run a line the thickness of veneer to be left on strings; run in a saw-cut down this up to the gauge-line, lay the lath on the drawing board with the cut-edge against the centre line, drive in two nails below saw-kerf Y to fix it, then bend the lath to the left until the kerf Y closes; this gives the width of the wedge-shaped blockings and the parallel laggings, Fig. 186.

Take the string and set out the winders and risers round the well-hole as described, gauge round for the veneer Q, and proceed

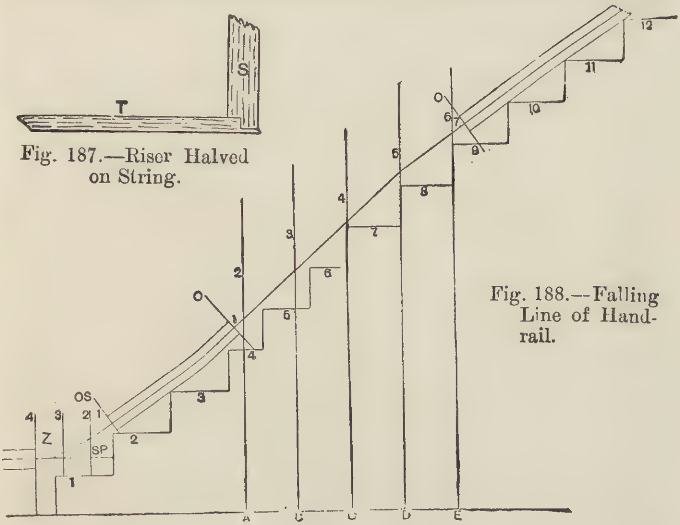


Fig. 187.—Riser Halved on String.

Fig. 188.—Falling Line of Handrail.

to cut out the superfluous stuff from springing to springing; this must be cut out vertical, that is, upright with the risers, and it must be under-cut as shown to prevent the blockings from lifting. On a piece of lining-paper set out from the lath the rise and going of the winders round the well, with a flyer at each end, marking on the springing lines, taking note of any easements at underside of strings; this paper can be used for setting out round the drum, and the string laid to it; it can also be used to set out the string when glued up. The string being fixed to pitch and springing lines S P on the drum, the blockings are shot in and well glued and rubbed; several of these blockings should be

of extra length, so that they can be screwed to the drum clear of the string, in order to keep it solid until the glue has set. For small wells the string is sometimes saw-kerfed or grooved in the solid, and pieces fitted in and glued, but the foregoing method is the best where it is possible to adopt it; the position of kerfs, etc., is found with the lath in the same manner as with the blockings. Canvas should be glued over the back of the blockings; in the case of large circular wall-strings, it is a good plan to glue and screw one or two thicknesses of thin stuff; this makes a very solid job. In putting together, the riser T should be halved into the string S, as shown in Fig. 187.

The stairs having been prepared and wedged up, the handrail may be proceeded with. As has been said, handrailing is a distinct art, but it may be touched upon here with benefit

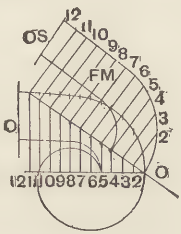


Fig. 189.

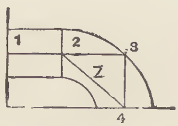


Fig. 190.

Figs. 189 and 190.—Face-moulds of Shank Piece.

to the reader. Fig. 188 shows the falling line of the rail with the steps set out and the tangent lines (not the circular lines as for strings) developed. A B C D E (Fig. 188) is the stretch out of the tangents A B C D E in Fig. 185, A and E being the springing lines, and C the centre line of wreath. The straight rail at the bottom has an easement worked at its top end to meet the wreath, and the centre line of the straight rail at the top is run down on the ordinary pitch to the first quarter D; the line continued down to the easement gives the pitches of wreath.

Fig. 189 shows a method of getting out the face-mould F M for the shank piece of scroll by the intersection of lines; this is almost self-explanatory. O S (Figs. 188 and 189) shows joint of shank piece, O being the joint line. Fig. 190 illustrates another method. In this the development of the first quarter of the scroll on plan (see Fig. 185) is set out on Fig. 188, the intersection of the pitch line with 3 giving the height of the level line from

which the half thickness of the rail is allowed each way. The diagonal on plan is then set out on the level line from springing to Z (Fig. 188), and from Z a line is drawn to cut the pitch at 2; this line is the length of the diagonal for the face-mould as shown at Z, Fig. 190, the tangent lines, 1, 2, 3, 4, are square to one another, and Z, 1, 2, 3, 4 (Fig. 188), should correspond with the same numbers on Fig. 190. The bevel for the lower joint (shown at 4, Fig. 190) can be obtained direct from the pitch-board by placing the stock of a bevel to the riser, and setting the blade to the pitch of the stairs; this bevel is shown at H, Fig. 185, and by setting off half the width of the rail parallel to the pitch-line, the distance 7, 8 is obtained, and marked off on each side from 4,

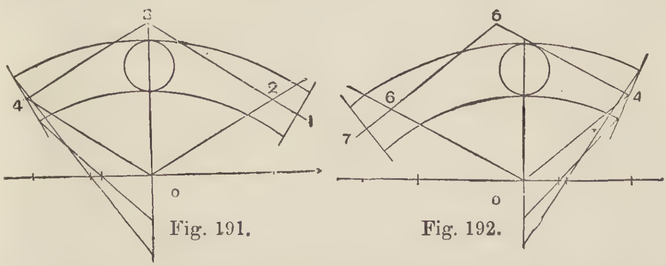


Fig. 191. Fig. 192.

Figs. 191 and 192.—Face-moulds for Top and Bottom Wreath Pieces.

Fig. 190, which gives the width of the mould at the lower joint. The curves are quarter ellipse.

To get the face-moulds for the wreath pieces, plane up two blocks of wood square to the same size as the tangent lines shown in Fig. 185. Letter one of these A B C, at right angles to correspond with the tangents for the bottom wreath piece; the top block will be C D E. From B 3 or D 5 (Figs. 193 and 194) take the pitch of the rail each way, and mark it on the corresponding blocks. It will be observed that there is one pitch to the lower half of the wreath, and that there are two to the upper half (see Fig. 188); cut the blocks to these pitches, and they will give the tangent lines for face-mould (Figs. 191 and 192). Figs. 193 and 194 show the elevation of the blocks when cut. Turn the blocks pitch side down on a piece of thin stuff and mark round them to obtain the tangent lines 2, 3, 4 and the parallel 2, 0, 4, Fig. 191, and 4, 5, 6 and 4, 0, 6, Fig. 192.

To get the bevels for the wreath take any position, as B E,

on the blocks, Fig. 193 and 194; square a line on the pitch, as shown at B, E, then hold the stock of the bevel to this line, setting the blade to the side of the block. The bevels should be marked on the ground plan, and half the width of the rail drawn parallel as shown at F, G, and I, Fig. 185; then 9, 10 will be half the width of the mould at 2 and 4 measured on the line 0, 4 and 0, 2, Fig. 191. This will be for the bottom wreath piece, which requires one bevel only, as the pitches are equal (see 1, 2, 3, and 4, Fig. 188). The bevels F and I, Fig. 185, will be for the upper wreath piece, F being the greater pitch will be the bevel for the joint at 7, and I the bevel for the joint at 4, Fig. 192;

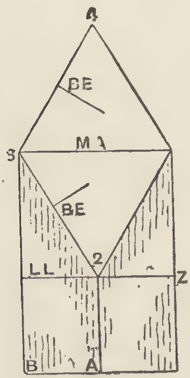


Fig. 193.

Figs 193 and 194.—Blocks for Top and Bottom Half Wreaths.

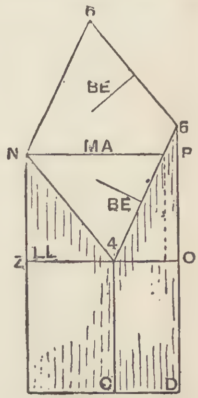


Fig. 194.

the distance 11 and 12 should be measured off each side of 6 on the line 0, 6 and similarly off 13, 14 each side of 4, Fig. 192. The straight portions of the rails 1, 2 and 6, 7 and the joint lines should be drawn square to the tangents, as shown at Figs. 191 and 192. The curves can be struck with string and pins or by bending a lath, first finding the minor axis so as to obtain a third point as follows: Take the block as shown at Fig. 194, and from the starting of the pitch at 4 draw two level lines L L on the adjacent surface as shown; along the edge D 5 measure from O to P the same distance as Z to N, square the short line from P to the pitch surface, then, joining this to N, gives the minor axis M A, which can be marked on the face-mould direct from the block. The bottom wreath piece having two equal pitches, the minor axis

will be across the diagonal, as at Fig. 193. The width of the face-mould along the minor axis is always the exact breadth of the rail.

The inside and outside of the rail from the centre of the well-hole on plan can be marked on the face-mould from the intersection of the tangent lines, and the curve struck round to these points. The major axis is always square to the minor, and the points at which to insert the pins, if struck with string, may be found in the following way : The width of the face-mould having been taken on the tangent lines, set out the joint for the centre of the wreath square to the tangent lines, set out the minor and major axes, and run on the minor axis line (see Figs. 191 and 192). Then take a rod and set out the minor axis both inside and outside of the rail on plan (Fig. 185). Apply the rod to the inside and outside of the rail at the centre joint line of the face-mould, and mark where they cut the major axis. Continue these lines until they cut the minor axis line that has been run on. The length of these two lines applied from the minor axis on the face-mould inside and out of the rail (shown by the circle) will give the points on the major axis at which to insert the pins, from which the curves of the rail are struck as in an ordinary ellipse.

Apply the moulds to the plank, mark round and saw square through to the face of the plank. The moulds should be laid on the wreath pieces and the tangent lines marked on ; then the joints should be planed square to the surface of the plank and also to the tangent lines, the ends should be centred, and the bevels applied. To work the twisted sides of the wreaths, two face-moulds should be got out for each wreath, one should be tacked to the upper and the other to the lower surface, and so that the tangent lines on the moulds join the bevel lines on the ends of the wreath pieces; the superfluous stuff should then be worked off straight through between the face-moulds so as to form the inner and outer vertical sides of the wreaths. The top and underside should next be worked square to the sides, taking care not to make any of the parts too thin.

In the case of large well-holes, it is not necessary to have the block for cutting the pitches any larger than 3 in. ; the pitches and bevels, etc., can be obtained from this, but the block, when turned down to mark the tangent lines for the face-moulds, must have these lines continued until they correspond with the pitches on the falling line (Fig. 188), that is, they must be the same lengths as 2, 3, 4, 5, and 6 for the two blocks.

CHAPTER XIII.

SHIPS' STAIRCASES.

In this chapter will be described the construction of three kinds of staircases in common employment on board ship. The first kind is really a ladder, but a description of it is necessary inasmuch as in situations where ordinary stairs, with their nice

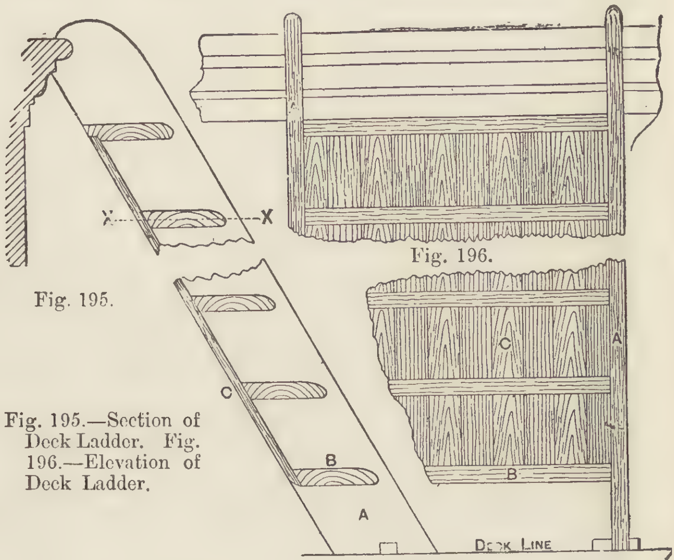


Fig. 195. Fig. 196.

Fig. 195.—Section of Deck Ladder. Fig. 196.—Elevation of Deck Ladder.

proportion of riser and tread, would be in the way, the common trap ladder is the only alternative. What is wanted is a means of getting from deck to deck which will take up but very little deck-room.

These ladders are of simple construction and are made portable. The steps are housed or raggled into the strings, and are usually close lined at the back, the steps being stopped

about $\frac{5}{8}$ in. from the back edge of the string, which would be checked the same depth as the raggles for the steps and the thickness of the lining, which is $\frac{5}{8}$ in. in this case. This check would be stopped at the top and bottom steps. Fig. 195 is a vertical section of the ladder, and Fig. 196 is the elevation.

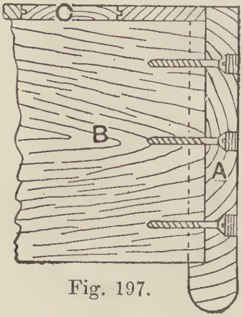


Fig. 197.

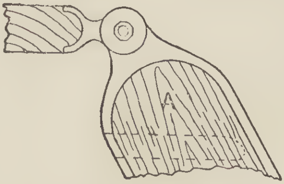


Fig. 198.

Fig. 197.—Horizontal Section through Step. Fig. 198.—Fastening at Top of Deck Ladder.

Fig. 197 is a section on the line X X (Fig. 195), showing the method adopted to secure the steps.

The top end of the string is scribed to fit on to the neck moulding and bottle-round of the deck above. In Fig. 195, A is the string, B the steps, and C the lining at the back rounded

Fig. 199.

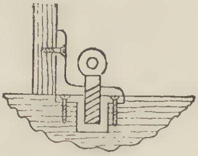


Fig. 200.

Fig. 199.—Plan of Snug. Fig. 200.—Fastening at Foot of Deck Ladder.

over at the bottom step. A cabin hook, such as is used to keep deck-house doors open, is sometimes used to fix the ladder at the top. A better plan, though a much more expensive one, is shown in Fig. 198. An iron shoe-piece is fitted on to the ends of the string, an eye-piece to correspond being fitted and screwed to the bottle-round, and a bolt passed through the holes.

Fig. 199 is a plan of a galvanised iron snug, which is screwed to the deck to prevent the foot of the ladder from slipping away. The bottom end of the string is checked to fit on to the top of the snug. Fig. 200 shows a better but more expensive method. A socket is sunk into the deck, where it is screwed. A

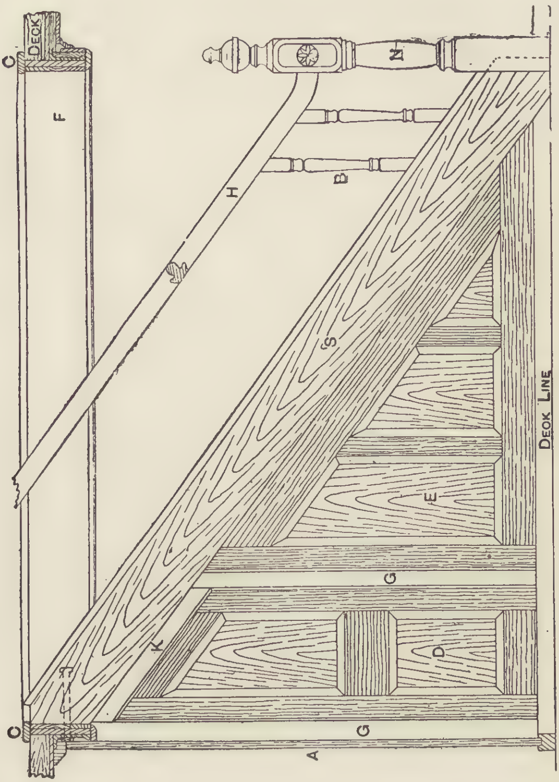


Fig. 201.—Elevation of Ship's Straight Stair.

piece of angle iron or brass, with a hole in it, is screwed to the bottom end of the stringer, and a pin with a thread on it is passed into the socket, which has been tapped to correspond.

Fig. 201 is an elevation and Fig. 202 the plan of a straight stair, leading from main deck to spar deck, and having a

spandrel frame below the string. S is the string, housed into the newel-post, N (Fig. 201), which is bolted to the deck. The string is bolted at the top to the half-beam. A (Fig. 201) is the bulkhead, formed of boards, and let into the cant below the strings, to receive the spandrel frame, E (Fig. 201), and

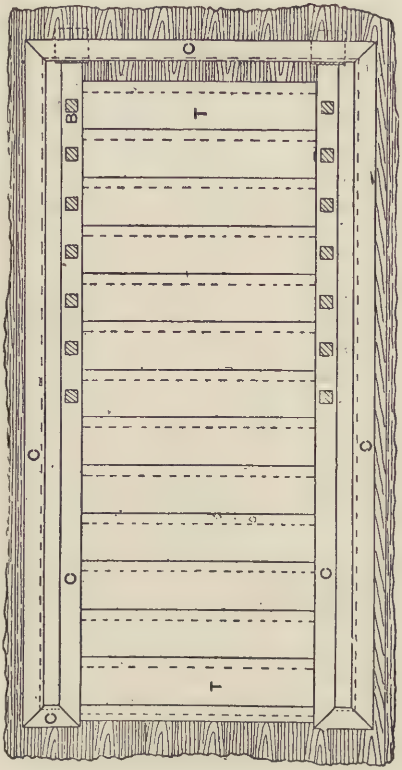


Fig. 202.—Plan of Ship's Straight Stair.

the door, D. G G are checked standards, fitted in between the string and cant; K is a checked door-lintel, screwed to the under-side of string; C is the cope on top of the string; it is carried round the well to receive the balusters, B, which are let into the cope and scarfed against the under-side of handrail H a

section of which is shown. The height of handrail should measure 2 ft. 9 in., taking it vertically from the nosing of the tread.

It will be seen that screws are used in the construction of a ship's stair where wedges would be employed in a house stair. The working which is going on throughout every part of a vessel when at sea renders wedges almost useless, as they would most probably be forced out after a very short time.

In Fig. 202 the cope C is shown to be carried round the well and sitting on the top of the finish, F, Fig. 201. T, Fig. 202, is the tread; the dotted lines show the position of the riser. The tread is 9 in. and the rise 7 in. The half-beam is

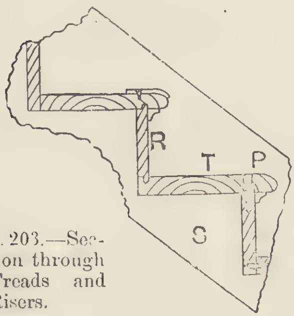


Fig. 203.—Section through Treads and Risers.


Fig. 204.—Portion of Step-plate.

grounded out and a facing is nailed on; the beam sole covers up the beam and grounds on the bottom, and the cope covers the joints at the top.

Fig. 203 is a vertical section of the stair, showing the construction. The treads and risers are housed into the string and screwed from the outside, the same as in deck ladders. T is the tread, R is the riser, and P is the step-plate overlapping the nosing of the treads.

Two different methods of fixing the riser are shown in Fig. 203. One riser is tongued into the bottom tread as well as the upper one. The other is simply butted against the lower tread, and screwed and tongued into the upper tread. The riser is fixed with screws passed through the tread, and the holes dowelled up. The metal step-plate—a portion of which is shown at Fig. 204—covers up the dowels. Fig. 205 shows the tread raggled into the

string and screwed. Fig. 206 shows a string, checked to receive the treads and risers. It is screwed and dowelled the same as Fig. 205.

Consideration will now be given to the design and construction of a ship's staircase having a landing halfway between the two decks joined by the staircase. A half plan of the stair is represented by Fig. 207. At the side of the well of the stair is a framed-up room, to be used for stores or as a cloak-room. The after end of the stair is securely fixed to a wood bulkhead, the polished framing or lining being carried all round the stairway on top of the string and fixed to the face of the bulkhead. Metal brackets are fixed to the face of the framing for supporting the handrail, which is kept out far enough to allow finger space. The newel post is in this case fixed to the deck, and the rail and string are returned to it in a curve. The string is fixed

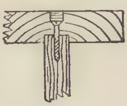


Fig. 205.

Fig. 206.

Figs. 205 and 206.—Method of Fixing Treads to String.

to the deck at the extreme top of the stair; the handrail which finishes on a level easing, and which is fixed to the framing at the top, is shown in Fig. 208.

The stair is constructed in two flights, one springing from the deck to a landing, and the other from the landing to the upper deck. The landing in the middle is carried on a frame which is supported by uprights fixed on the lower deck, as shown by Fig. 208.

The treads and risers are raggled in as is usual, and are screwed to each other and nailed from the outside. When the string is exposed, it may be covered with a moulded plate. The well of the stair, which may be finished as shown by Fig. 208, has a mock nosing carried all round it, below this being a hardwood facing, terminating in a beam sole.

The level easing and the wreath will now be dealt with. The former is got out very easily, so the operation will not be dealt with here. The wreath or central piece requires more skill. An enlarged plan of the wheel or wreath and of two or three of

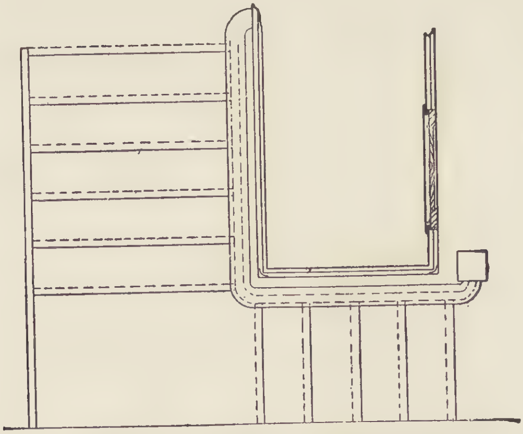


Fig. 207.—Half Plan of Ship's Stair.

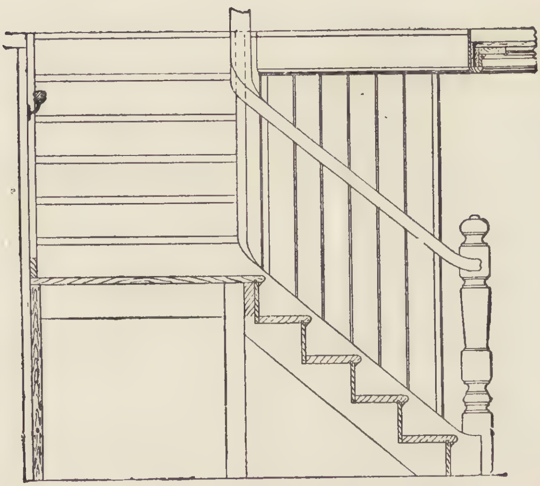


Fig. 208.—Section of Ship's Stair.

the steps is shown at Fig. 209, and from it will be noticed that in this case the riser A′ (A being the nosing) is placed on the springing line B. The plan of the rail C, with the centre line D, should be drawn down, and the position of the joints E determined.

The centre line of the rail D is developed by taking the distance from solid to solid, as the face of the riser is called, and the distance from the spring to the point where the two centre lines of the rail meet, and then on to the next spring, and so on,

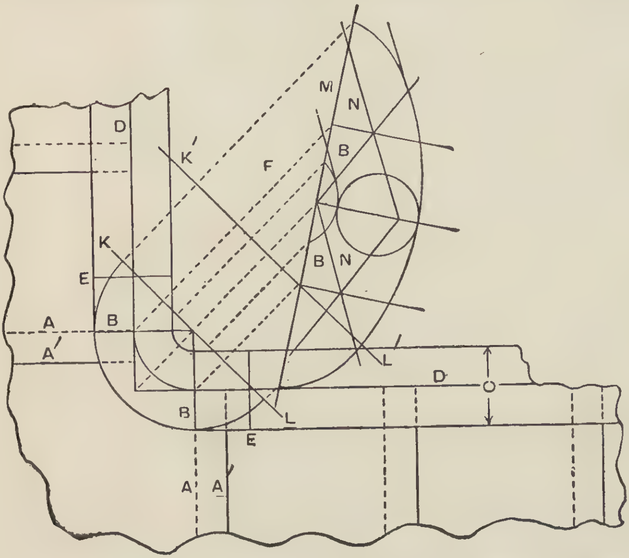


Fig. 209.—Plan of Wreath showing Method of Getting out Face-Mould.

transferring them to the paper or board, as the case may be, and squaring the risers up, marking the height upon them, and drawing the level lines or the width of the tread in the manner shown at Fig. 210.

The falling line of the rail is found as follows : Lay a straightedge along the solid of the steps, and if it catches all the points, so much less labour will be required in the wreath ; but if the upper line is some inches above the run of the other, as seen in Fig. 210, take the distances from the springs B to the joints E,

shown on the plan (Fig. 209), and transfer them to their levels; then square them up till they cut the line of the rail. A line drawn passing through these two points will be the falling line of the rail for the wreath. Square across from the points where this falling line intersects the spring lines, as shown by dotted lines at Fig. 210, and this will give the height F, Fig. 209, to be used in drawing out the face moulds.

Before leaving the development, the bevels may be obtained.

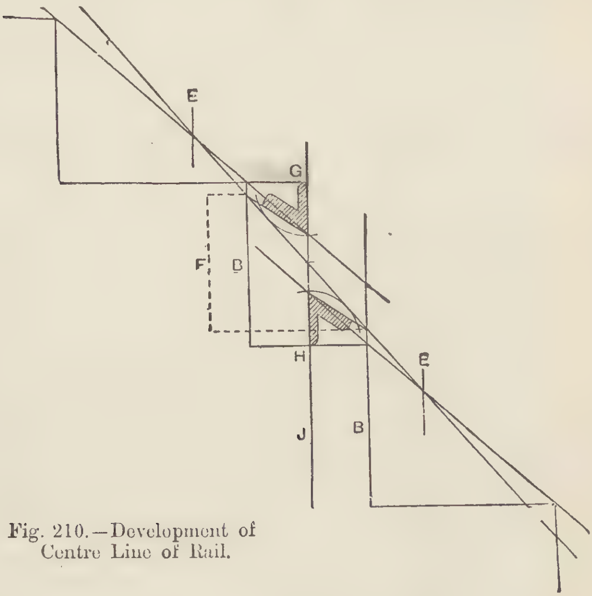


Fig. 210.—Development of Centre Line of Rail.

The falling line of the rail is continuous from joint to joint, one bevel thus sufficing; two are illustrated so as to demonstrate that, if correctly drawn, they are alike. With G or H, Fig. 210, as centre, and with the falling line as radius, draw with compasses the arc to cut the centre line of the wreath J; from the point thus obtained draw a line to the point of intersection of the falling and the spring lines. This gives the bevel for applying on the ends of the wreath to produce the necessary twist. Returning to the plan, Fig. 209, draw a diagonal line across the small

square formed by the spring and tangent lines, and then draw another at right angles to it, as shown at K L (Fig. 209); this is called the seat, but owing to its being too close to the plan to allow the face-mould to be drawn out, another parallel line is drawn a little distance away from it, as shown by K′ L′. Project the different points at right angles to the seat, as shown by dotted lines, and on the spring line of the high end of the wreath draw the height F as transferred from the development (Fig. 210).

To obtain the pitch of the plank, draw on Fig. 209 a line from the point obtained by the height to the point made by the intersection of the lower spring line on the seat K L. This line, M, is the

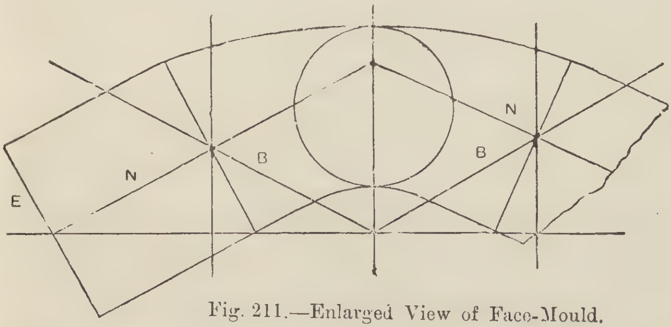


Fig. 211.—Enlarged View of Face-Mould.

pitch of the plank. Square across all lines to cut the pitch line, and square over as shown. Take the distances from the lower seat, and transfer them to the corresponding lines squared over from the pitch line. Draw the tangent lines N and the spring lines B; also draw the circle equal to the true width of the rail. With the pitch of the plank as the major axis, and the centre line as the minor, draw the ellipse, the half major axis being obtained by turning round the inside and outside of the wreath until they cut the seat line, and squaring them up. At the points where the ellipse cuts the springing lines, draw the sides of the rail parallel to the tangent lines, and take the length from spring to joint in the development (Fig. 210); transfer it to the face-mould, and draw the joint line E at right angles to the tangent line N, as shown in the enlargement at Fig. 211.

The working of the wreath to the square may now be con-

sidered. As there is a small ramp in this wreath, it will be necessary to obtain stuff which is a little thicker than actually measured, by applying the bevel on a board and squaring the rail over, as shown at Fig. 212. It may be mentioned that

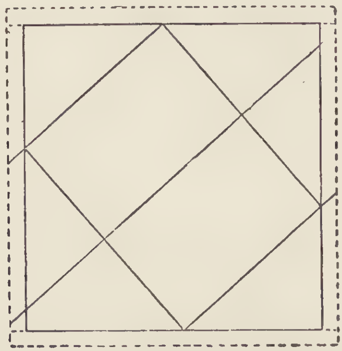


Fig. 212.—Diagram showing Thickness of Wood required with Ramp.

a wreath with a ramp is much more difficult to work than when it is without one. To obtain the extra thickness, measure the distance on the development (Fig. 210) from where the line is squared across at the height to the line of the upper rail. The

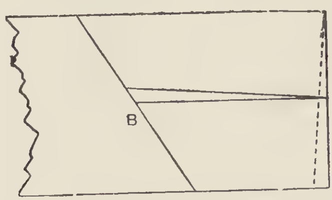


Fig. 213.—Method of Squaring Butts.

extra amount of stuff that should be allowed to remain is shown at Fig. 212. Cut out the wreath to the face-mould, allowing a little surplus in width. Fair up the top side, apply the mould, and transfer the tangent and spring lines. Square the butts off the top and from the tangent lines. This method of squaring the butts a second time is a slow but sure one, especially for

beginners, but by those who are more advanced the upper shank end can be stripped to the level and the rail wrought square from the butt. After squaring from the tangent lines, get the dead centre of the stuff on end, and apply the bevel, holding the

Fig. 214.—Half-cross Section of Rail.

wreath in its proper position to ensure the bevel being correctly applied; square over the exact size of the square section of the rail from the bevelled ine (see Fig. 212),

Fig. 215.—Half-cross Section of Rail in Two Parts.

and taking the centre bevelled line as the new tangent line, apply the face-mould, which will at once show the exact amount of material to be taken off. Fair up the side first, and then plumb down the spring lines and square in the

centre line from the butts. Take the distance on the spring from the falling line to the upper line of the rail, and transfer it to the side of the wreath at the spring lines, lowering it at the top and raising it at the bottom. Draw lines from the new points at the spring to the centre line at the butt, and square the butts anew to these lines. The manner of doing this is shown roughly at Fig. 213. This wreath can be squared-up in a similar manner by the aid of two face-moulds, as described on p. 143. In working the wreath, render the ramp gracefully, or break it as much as possible, and then apply a thin template of the same shape as the rail, having the bolt and dowel holes centred on it, and draw in everything. Bolt up the rail, and test it in position, if possible; if it is correct, proceed to work the moulding. The various parts are lettered uniformly throughout, Figs. 209, 210, and 211.

Fig. 214 is a half cross section of a rail. Fig. 215 shows a half cross section of an alternative design in two parts, but although it is a better rail than the one already described, it is more expensive.

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